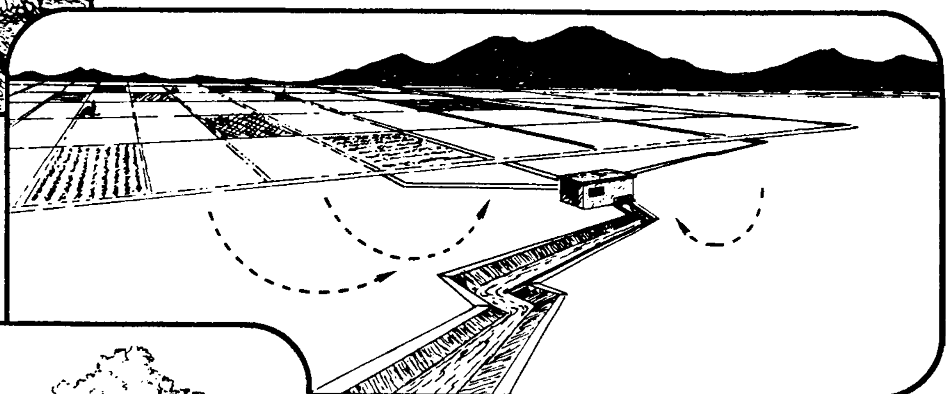
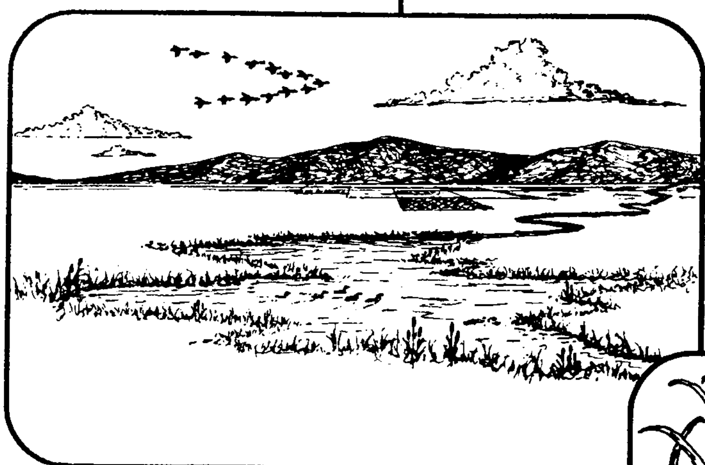
Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Lower Rio Grande Valley and Laguna Atascosa National Wildlife Refuge, Texas, 1986-87





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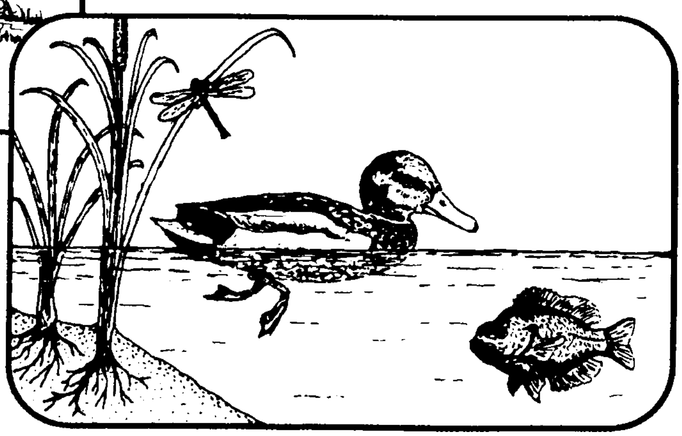

U.S. DEPARTMENT OF THE INTERIOR
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U.S. Geological Survey
U.S. Fish and Wildlife Service
U.S. Bureau of Reclamation

Reconnaissance Investigation of Water-Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Lower Rio Grande Valley and Laguna Atascosa National Wildlife Refuge, Texas, 1986-87

By Frank C. Wells, U.S. Geological Survey,
Gerry A. Jackson, U.S. Fish and Wildlife Service,
and William J. Rogers, U.S. Bureau of Reclamation

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 87-4277

Austin, Texas

1988

DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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METRIC CONVERSIONS

Factors for converting inch-pound units to metric (International System) units are given in the following table:

Multiply inch-pound unit	By	To obtain metric unit
acre	0.4047	hectare
acre-foot (acre-ft)	0.001233	cubic hectometer
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
mile per hour (mi/h)	1.609	kilometer per hour

Temperature data in this report are in degree Celsius (°C) and may be converted to degree Fahrenheit (°F) by the folowing formula:

$$°F = 1.8\ (°C) + 32.$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

Data in this report have been collected, analyzed, and reported by various governmental agencies. Consequently, various reporting units have been used in reporting the data. The following table is provided to assist the reader in equating the various reporting units:

parts per million (ppm) = milligrams per liter (mg/L)
= micrograms per gram (μg/g)
= milligrams per kilogram (mg/kg)
parts per billion (ppb) = micrograms per liter (μg/L
= micrograms per kilogram (μg/kg)

RECONNAISSANCE INVESTIGATION OF WATER-QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION DRAINAGE IN THE LOWER RIO GRANDE VALLEY AND LAGUNA ATASCOSA NATIONAL WILDLIFE REFUGE, TEXAS, 1986-87

By

Frank C. Wells, Gerry A. Jackson, and William J. Rogers

ABSTRACT

In 1986, the Department of the Interior conducted reconnaissance investigations in nine areas of the western conterminous United States to determine whether irrigation drainage has caused or has the potential to cause harmful effects to human health, fish, and wildlife, or may adversely affect the suitability of water for beneficial uses. Data collected in the lower Rio Grande valley and Laguna Atascosa National Wildlife Refuge reconnaissance investigation indicate that concentrations of dissolved minor elements in water are small. The maximum dissolved concentrations of arsenic, cadmium, mercury, chromium, selenium, and zinc exceed the 75th-percentile baseline values developed for the study; however, maximum dissolved concentrations of cadmium, mercury, and selenium exceeded the 75th-percentile baseline values by 1 microgram per liter or less. Concentrations of dissolved boron increased significantly from west to east. The smallest concentration of dissolved boron, 220 micrograms per liter, was detected in International Falcon Reservoir. The largest concentration of dissolved boron, 11,000 micrograms per liter, was detected on the refuge in Athel Pond.

No chlorophenoxy herbicides were detected in water during the June 1986 sampling. Simazine, prometone, and atrazine were the only triazine herbicides detected, and concentrations of these herbicides did not exceed 0.8 microgram per liter. DDE, the only organochlorine insecticide detected in water, was detected at two locations at concentrations of 0.01 micrograms per liter. Methyl parathion, malathion, and diazinon were the only organophosphorus compounds detected in the June 1986 sampling, and the maximum concentrations of these compounds were 0.75, 0.71, and 0.26 micrograms per liter, respectively. The analysis of three samples collected in August 1986 indicate that the types of pesticides collected during runoff were similiar to those detected during the June 1986 sampling. The exception was that the herbicide 2,4-D was detected during runoff.

Concentrations of dissolved cadmium exceeded the chronic criteria for freshwater aquatic life in the Cayo Atascoso in the Laguna Atascosa National Wildlife Refuge. Chromium exceeded the acute and chronic freshwater criteria at four locations in the refuge and in the Laguna Madre. Chromium also exceeded the chronic saltwater criteria in Athel Pond. Concentrations of dissolved copper exceeded the acute and chronic criteria for saltwater aquatic life at 13 locations. Mercury exceeded the chronic criteria for freshwater

and saltwater aquatic life at three locations, and dissolved nickel concentrations exceeded the chronic criteria for saltwater aquatic life in the Rio Grande at Anzalduas Dam and in the Resaca de los Frenos near Russeltown.

No organophosphorus insecticides, polychlorinated napthalenes, or polychlorinated biphenyl compounds were detected in four bed-sediment samples. DDE, an organochlorine insecticide, was detected in all four samples at concentrations ranging from 0.2 to 34 micrograms per kilogram. Chlordane, DDD, DDE, DDT, and dieldrin were all detected in the Resaca de los Fresnos at U.S. Highway 77 at San Benito with concentrations of 4.0, 9.7, 9.3, 7.3, and 0.1 micrograms per kilogram, respectively. Data collected by U.S. Fish and Wildlife Service in 1985 indicate that DDE was detected in approximately 75 percent of the bed sediment samples analyzed. The maximum concentration detected in that study was 6.0 micrograms per gram; the median concentration was 0.01 micrograms per gram.

Minor-element data from 22 fish samples indicate that the maximum concentrations of arsenic, copper, mercury, selenium, and zinc exceeded the 85th-percentile baseline concentrations established by the U.S. Fish and Wildlife Service for the National Contaminant Biomonitoring Program. None of the median concentrations of these minor elements exceeded the baseline concentrations. The maximum concentrations of aluminum, barium, iron, manganese, and tin were detected in fish collected from International Falcon Reservoir. This reservoir stratifies in the summer, and minor elements may be released from the bed sediments in the deep parts of the reservoir and incorporated into the food chain.

Toxaphene was detected in 11 fish samples; detectable concentrations ranged from 0.98 to 5.1 micrograms per gram, wet weight. DDT also was detected in 11 fish samples with concentrations ranging from 0.021 to 0.066 micrograms per gram, wet weight. DDD was detected in 21 fish samples; concentrations ranged from 0.015 to 0.16 micrograms per gram, wet weight. DDE was detected in all 22 fish samples, and concentrations ranged from 0.36 to 9.9 micrograms per gram, wet weight. The maximum concentrations of DDT and DDD exceeded the 1980-81 baseline concentrations. The median and maximum concentrations of toxaphene and DDE exceeded the 1980-81 baseline concentrations. The largest concentrations of toxaphene, DDD, and DDE in fish were all measured in samples collected at the Main Floodway near Progreso.

INTRODUCTION

During the last several years, there has been increasing concern about the quality of irrigation drainage--surface and subsurface water draining irrigated land--and its potential effects on human health, fish, and wildlife. Greater than background concentrations of selenium have been detected in subsurface drainage from irrigated land in the western part of the San Joaquin Valley in California. In 1983, incidences of mortality, birth defects, and reproductive failures were discovered by the U.S. Fish and Wildlife Service at the Kesterson National Wildlife Refuge in the western San Joaquin Valley, where drainage water was impounded. In addition, potentially toxic trace elements and pesticide residues have been detected in other areas in western States that receive irrigation drainage.

Because of concerns expressed by the U.S. Congress, the Department of the Interior (DOI) initiated a program in late 1985 to identify the nature and extent of water-quality problems induced by irrigation drainage that might exist in the western States. In October 1985, an interbureau group known as the "Task Group on Irrigation Drainage" was formed within the DOI. The Task Group subsequently prepared a comprehensive plan for reviewing irrigation-drainage concerns for which the DO1 may have responsibility.

The DO1 developed a management strategy and the Task Group prepared a comprehensive plan for reviewing irrigation-drainage concerns. Initially, the Task Group identified 19 locations in 13 States that warranted reconnaissance investigations. These locations relate to three specific areas of DO1 responsibilities: (1) irrigation or drainage facilities constructed or managed by the DOI; (2) national wildlife refuges managed by the DOI; and (3) other migratory-bird or endangered-species management areas that receive water from, DOI-funded projects.

Nine of the 19 locations in 13 States were selected for initiation of reconnaissance investigations in 1986. The Lower Rio Grande Valley-Laguna Atascosa National Wildlife Refuge area was one of those selected. The others were:

Arizona-California: Lower Colorado-Gila River Valley area
California: Salton Sea area and Tulare Lake area
Montana: Sun River Reclamation Project area and Milk River Reclamation Project area
Nevada: Stillwater Wildlife Management area
Utah: Middle Green River basin area
Wyoming: Kendrick Reclamation Project area.

Each reconnaissance investigation was conducted by interbureau field teams composed of a scientist from the U.S. Geological Survey as team leader, with additional Geological Survey, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation scientists representing several different disciplines. The investigations were directed toward determining whether irrigation drainage: (1) Has caused or has the potential to cause significant harmful effects on human health, fish, and wildlife, or (2) may adversely affect the suitability of water for other beneficial uses.

Purpose and Scope

This report describes the results of the Lower Rio Grande Valley-Laguna Atascosa National Wildlife Refuge area. The purpose of this report is to provide a general description of the study area, to describe the general hydrologic setting of the lower Rio Grande Valley, to define the basic data-collection program, and to evaluate the data against national baseline concentrations and water-quality criteria so that the Department of the Interior may determine if irrigation waters have caused, or have the potential to cause, harmful effects on human health, fish, and wildlife, or other water uses.

Acknowledgments

The authors acknowledge and thank Ray Rauch, Refuge Manager at the Laguna Atascosa National Wildlife Refuge, and members of his staff for their cooperation and assistance during the planning and data-collection efforts of this investigation. Without the use of refuge facilities, equipment, and personnel, this study could not have been conducted in an efficient manner. The authors also thank Rick Goss, U.S. Geological Survey, Houston, Texas; Ron Severson, U.S. Geological Survey, Lakewood, Colorado; and Thomas Maurer, U.S. Fish and Wildlife Service, Corpus Christi, Texas, for their assistance in data collection.

GENERAL DESCRIPTION OF STUDY AREA

The study area is located principally in the four southernmost counties in Texas--Starr, Hidalgo, Cameron, and Willacy (fig 1.). This area consists of approximately 4,240 mi^2 and generally is known as the lower Rio Grande valley. Most of this area is a broad, flat, coastal plain extending from the Gulf of Mexico and Laguna Madre to a hilly upland area near the center of Starr County. Land surface slopes gently from sea level at Laguna Madre to an elevation of about 100 ft above sea level in central Hidalgo County and then more steeply to an elevation of about 250 ft in western Hidalgo County. There, rolling hills begin that increase in elevation to a maximum of about 500 ft in central Starr County. The eastern slopes of this plain have long shallow depressions and undulations grading into sinks and dunes in the northern part. Along the southern edge of the coastal plain, the land slopes eastward to merge with the Rio Grande delta. The delta slopes eastward and northeastward away from the Rio Grande. The Rio Grande delta contains many old river channels known locally as "resacas" (Vandertulip and others, 1974).

The economy of the area is largely agricultural, but manufacturing, food processing, mineral production, and tourism also are of major importance. Much of the land used for production of crops is irrigated, although dryland farming has increased in recent years. During 1984, records of the International Boundary and Water Commission (IBWC) indicate that slightly more than 1 million acre-ft of water were supplied to irrigate slightly more than 750,000 acres. Much of the irrigated land is located in the southern and southeastern parts of the study area. Principal crops in the area include cotton, citrus, sugar cane, and vegetables. In the northern part of the study area, land use consists of dryland farming and large ranches for cattle, sheep, and goats.

According to the 1980 census, the population of the four-county area was approximately 537,800. Counties having the largest populations in the study area are Hidalgo and Cameron with populations of approximately 283,000 and 210,000, respectively. The population of the four-county area more than doubled between 1940 and 1980 with the population increasing from almost 215,800 to approximately 537,800.

Refuge Description

The Laguna Atascosa National Wildlife Refuge lies along the Laguna Madre in Cameron and Willacy Counties at the southern tip of Texas in the lower Rio

The refuge provide habitat for a wide varity of wildife, many of which are unique to the lower Rio Grande valley. Land development has occurred and continues to occur at a rapid pace in the valley. Concerns over this valuable and unique habitat prompted the U.S. Fish and Wildlife Service to develop a Land Protection Plan for the Rio Grande valley.

Biota

The lower Rio Grande valley is part of the Tamaulipan biotic province and has been designated as the Matamoran district. The valley is a deltaic floodplain at the eastern end of the Rio Grande and is commonly referred to as an ecological crossroads between the warm, humid tropical forests to the south in Mexico and the hot, dry Chihuahuan desert to the north and west. Unique assemblages of plants and animals are found in this region, and many species that are native to the United States are found only in this area. The Tamaulipan province is dominated by thorn-brush vegetation, including mesquite (Propis glanduosa), granjeno (Celtis pallida), guaycan (Porlieria augustifolia), cenizo (Leucophyllum frutscens), white brush (Aloysia gratissima), prickly pear (Opuntia englmannii), tasajillo (Opuntia leptacaulis), and various species of acacia and mimosa. The predominant plant species within the Matamoran district include retama (Parkinsonia aculeata), Texas ebony (Pithecellobium flexicaule), anacahuite (Cordia boissieri), and anacua (Ehretia anacua). Johnston (1955) noted that salinity tolerance, not elevation above sea level, was primarily responsible for the distribution of vegetational zones in the lower Rio Grande valley.

There are 525 vertebrate species within the Matamoran district of South Texas, including 50 species of mammals, 349 species of birds, 22 species of amphibians, 58 species of reptiles, and 46 species of fish, but not including all those living in Laguna Madre. Several of these species are listed on the DOI's Endangered Species List, including the ocelot (Felis paradalis) and jaguarundi (Felis yagouaroundi cacomitlii).

Land Use

Europeans explored the mouth of the Rio Grande as early as 1519, but it was not until 1749 that Colonel Escandor established the first European settlement along the Rio Grande for the Spanish Crown. In about 1767, land grants were given to colonists and ranching became the primary activity. After years of fighting, the United States gained control of the area in 1848 as a result of the Treaty of Guadalupe Hidalgo. Long distances to markets and poor transportation, however, restricted development in the valley until a railroad was constructed in 1904.

Although irrigation began in 1876, it was not until 1905 that large-scale irrigation ensued. Many of the land companies that had vigorously promoted the valley and its irrigation became bankrupt in 1915. Farmers then began to organize irrigation districts. The cattle industry began a steady decline as more acreage came under cultivation. Cotton, citrus, and vegetables were among the first crops. Cotton is still considered the principal crop today. Many other crops have gained in importance, however, including vegetables, citrus, corn, sorghum, and sugarcane. Approximately 78 percent of the land in Cameron County, 85 percent of the land in Hidalgo County, 76 percent of the land in Starr County, and 71 percent of the land in Willacy County are either farms or ranches according to the Texas Department of Agriculture (1985). Much of this is irrigated land with virtually all water originating from the Rio Grande with relatively little ground-water use.

The network of irrigation canals and drainages in the lower Rio Grande valley continues to expand. The major drainages are the Main Floodway-Arroyo Colorado system, the North Floodway, the Raymondville Drain, and the Hidalgo-Willacy County Drainage District No. 1 Drain, locally referred to as the "Big Ditch." Land leveling with the installation of down drains and the installation of subsurface drain structures are proceeding at a rapid pace in the valley, despite the recent economic decline in the area.

Native-brush habitat once extended as far as 30 mi on either side of the Rio Grande (Inglis, 1964). However, more than 95 percent of this habitat has been destroyed (Marion, 1976). This has an extremely detrimental effect on native plant and animal species. Three National Wildlife Refuges and several State tracts managed by the Texas Parks and Wildlife Department protect portions of the remaining habitat. The U.S. Fish and Wildlife Service is pursuing an aggressive land protection plan to protect and maintain 10 distinct wildlife communities, totaling 107,500 acres, in the lower Rio Grande valley. When completed, a "wildlife corridor" will be created to directly benefit at least 115 species including the white-wing dove (Zenaida asiatica), plain chachalaca (Ortalis vetula), numerous neotropical bird species, and several endangered species, including the ocelot, jaguarundi, bald eagle (Haliaeetus leucocephalus), brown pelican (Pelecanus occidentalis), and the Arctic peregrine falcon (Falco peregrinus tundrius).

Climate

The climate of the lower Rio Grande valley is subtropical with a variation in precipitation from an average annual low of 21.8 in. at McCook, located in the northwestern part of the valley, to approximately 30 in. in the Brownsville, Harlingen, and Port Isabel area. The average annual temperature ranges from a low of 21.5 °C at Port Mansfield to a high of 23.5 °C at McAllen. The annual evaporation recorded during 1975-84 was 59.4 in. at McCook and 56.9 in. at Weslaco. The maximum temperature high of 41.7 °C during 1975-84 was recorded on July 22, 1980, and May 4, 1984, at Raymondville, and also on May 4, 1984, at Mission. The minimum temperature of -9.5 °C during 1975-84 was recorded at McCook and Raymondville on December 26, 1983. The average annual humidity is approximately 75 percent with extremely variable winds that prevail from the southeast at an average of 4 mi/h. The winds exert a marked influence on precipitation and evaporation in the valley. The prevailing southeasterly winds along the coast transport moisture-laden Gulf air directly into Cameron and Willacy Counties providing water vapor that contributes to the higher annual precipitation and higher humidity along the coastal regions. Southerly winds crossing the hot Mexican countryside south of the Rio Grande into Hidalgo and Starr Counties are hotter and drier, and, thus, contribute to lower annual precipitation, lower humidity, and higher maximum temperatures.

General Geology

The geologic formations exposed at the land surface in the lower Rio Grande valley are sediments of Tertiary and Quaternary age. The sediments are several thousand feet thick and consist chiefly of unconsolidated deposits of clay, silt, sand, and gravel. In places, the outcrops are blanketed by soil and windblown deposits. The formations are not uniform in composition or thickness and change considerably in short distances.

Rocks that crop out in the lower Rio Grande valley are of Pliocene, Pleistocene, and Holocene age. The Goliad Sand and associated rocks of Pliocene age and the overlying Lissie Formation of Pleistocene age either crop out or subcrop at shallow depths beneath the land surface throughout most of the eastern and central parts of Hidalgo County. The strata may be as much as 1,000 ft thick in the outcrop area and they thicken toward the Gulf. They dip eastward beneath younger formations and are penetrated by wells far below the land surface along the coast. The Pleistocene rocks, which include the Beaumont Clay and associated rocks, crop out in a broad zone of eastern Hidalgo and northern Cameron Counties. These rocks also may be as much as 1,000 ft thick in the outcrop area and they also thicken toward the Gulf. The dip is eastward at a rate somewhat less than that of the underlying rocks. Holocene deposits consisting of clay, silt, sand, and gravel are as much as 400 ft thick in the flood plain of the Rio Grande (G. Cromack and W. Broadhurst, U.S. Geological Survey, written commun., 1945.)

Soils

Soils in the lower Rio Grande valley generally are sandy and are of Holocene age. The dominant soils are the Willacy, Brennan, Hidalgo, Victoria, Harlingen, Laredo, Cameron, Medio, Delfina, and Orelia series. Their surface textures range from dense clays to fine sandy loams. Soils within and adjacent to the Laguna Atascosa National Wildlife Refuge belong to the Laredo-Lomalta series. Laredo soils have a surface layer of dark grayish-brown, calcareous, silty, clay loams. They are well drained and moderately permeable. Lomalta soils have a surface layer of light-gray, calcareous clay about 5 in. thick. The underlying material is stratified loamy materials. These soils are poorly drained and are slightly permeable. Soils in the lower Rio Grande valley are alkaline, with sodium chloride, sodium sulfate, and sodium bicarbonate the most common alkali salts.

HYDROLOGY

Surface Water

Discharge in the lower Rio Grande is controlled by releases from International Falcon Reservoir. Water in the reservoir is impounded by Falcon Dam, which is the most downstream of the major international storage dams authorized for construction on the Rio Grande by the Water Treaty of 1944 between the United States and Mexico. The dam is located 86.1 river mi downstream from Laredo, Texas, and approximately 275 river mi upstream from the Gulf of Mexico. The reservoir has a conservation storage of 2,667,588 acre-ft and a maximum storage capacity of almost 4 million acre-ft.

Much of the water released from International Falcon Reservoir is diverted for municipal and agricultural use in the United States and Mexico (fig. 2). Major releases from the reservoir occur in April, May, and June to satisfy needs of irrigation interests in the United States and Mexico during the months of increased water demand. Average diversions by the United States and Mexico during January through June exceed the total flow in the Rio Grande at Brownsville. Water for use in the United States is diverted all along the river. Much of the water is diverted by local irrigation districts and stored in holding ponds. Most of the water for use in Mexico is diverted at Anzalduas Dam.

The Rio Grande drains only a small part of the valley. The most downstream tributary to the river is located 10 mi west of Mission in southwestern Hidalgo County. A low ridge extends from the southern edge of the upland plain near Mission to eastern Hidalgo County, where it flattens and merges with the general land level. This ridge prevents runoff in the area north of the ridge from flowing to the Rio Grande. Much of the eastern part of the valley is drained by small coastal streams, the Arroyo Colorado, resacas, and drainage ditches that flow into Laguna Madre.

Two diked floodways, the Main Floodway and the North Floodway, dissect the valley. They were constructed by the IBWC to receive floodwaters in excess of the capacity of the river channel and to convey them to the Gulf. The Main Floodway roughly parallels the Rio Grande across the southern part of Hidalgo County, merges into the Arroyo Colorado southwest of Harlingen, and empties into Laguna Madre northeast of Harlingen. The North Floodway branches off northward from the Main Floodway about 2 mi southwest of Mercedes and continues north for approximately 14 miles where it turns eastward to empty into Laguna Madre.

The IBWC estimates that less than 10 percent of the water withdrawn for irrigation is returned to Rio Grande (U.S. Department of State, 1984). The Arroyo Colorado carries much of the natural drainage and irrigation-return flows from the southern and western parts of the study area. The Arroyo Colorado discharges into Laguna Madre at the northern end of the Laguna Atascosa National Wildlife Refuge. The Raymondville Drain drains northern parts of the study area and discharges into the Laguna Madre east of Raymondville. A newer drain, known locally as the "Big Ditch", also drains some of the northern parts of the study area and discharges into the Laguna Madre between the Raymondville drain and the Arroyo Colorado.

The principal inflow to the refuge is through the Cayo Atascoso. The Cayo Atascoso flows into the Laguna Atascosa, which is the largest lake on the refuge. The Cayo Atascoso continues on to the northern side of the refuge and ultimately discharges into the Arroyo Colorado. Although the Cayo Atascoso continues past the Laguna Atascosa, sediments have been deposited near the outlet of Laguna Atascosa to such an extent that the Laguna Atascosa can no longer be completely drained.

The refuge also receives agricultural drainwater through the Resaca de los Cuates. This resaca is part of a drainwater system that is managed by several drainwater districts.

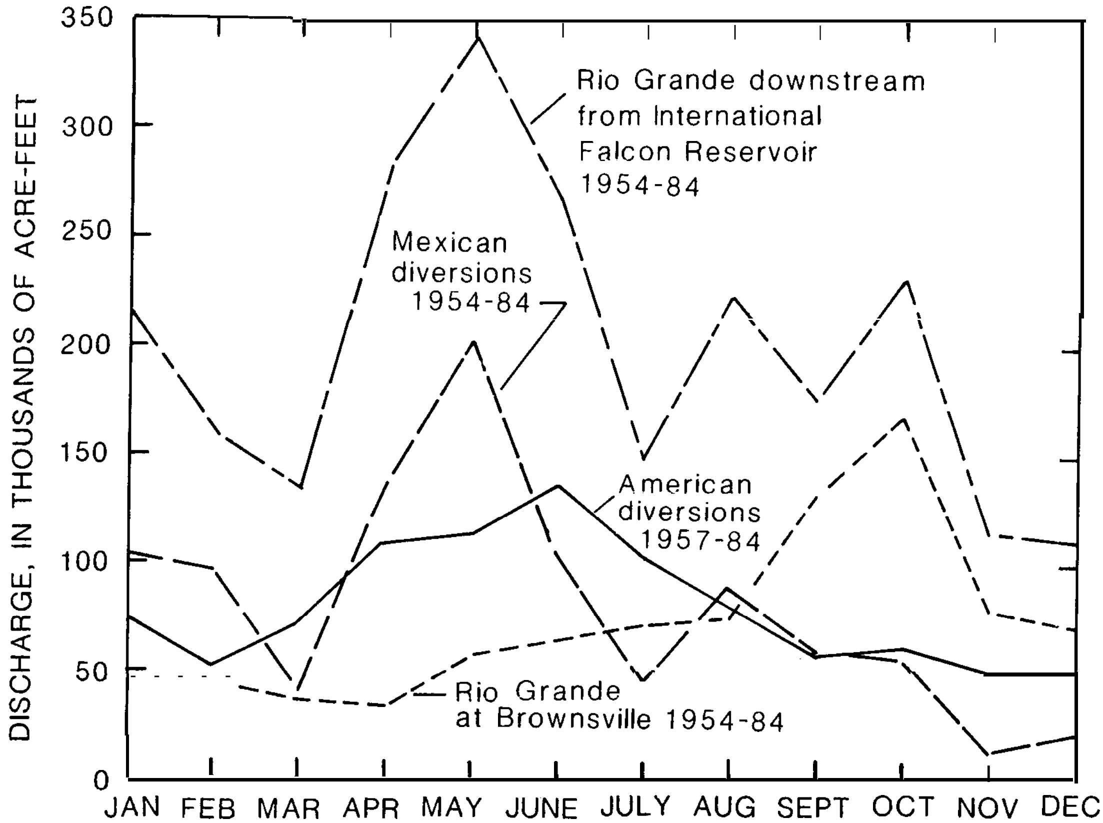


Figure 2.--Average monthly discharges and diversions at selected locations in the Rio Grande Valley.

Ground Water

The ground-water resources of the lower Rio Grande valley have been described by Baker and Dale (1961) and the following description of ground water in the lower Rio Grande valley has been abstracted from the published report.

There are four major aquifers in the lower Rio Grande valley that are suitable for supplying water for irrigation, public supply, or industrial uses. These can be differentiated on the basis of stratigraphic position, geographic location, depth below land surface, lateral continuity, yields of wells, and quality of water. Some of the aquifers are composed of parts of two or more stratigraphic units.

The Oakville aquifer, composed of the Miocene Oakville Sandstone, is an important source of water for industrial use in the northeastern part of Starr County. The Oakville Sandstone underlies the eastern one-half of Starr County and in Hidalgo, Cameron, and Willacy Counties. The Oakville lies unconformably on the Miocene Catahoula Tuff and is unconformably overlain by the Miocene Lagarto Clay and the Goliad Sand. The Oakville probably does not crop out in the lower Rio Grande valley because it is overlapped by the Goliad Sand.

The Linn-Fayville aquifer supplies irrigation water in central Hidalgo County. The aquifer consists of interbedded layers of sand and clay with some caliche near the land surface. The total thickness of the water-yielding beds ranges from about 30 to 60 ft; however, the beds are laterally discontinuous, and at some places are too thin to yield much water. Most of the water is pumped from wells less than 100 ft deep.

The Rio Grande aquifer underlies the Rio Grande valley in southeastern Starr, southern Hidalgo, and western Cameron Counties, and possibly a small part of southwestern Willacy County. This aquifer consists of beds of water-yielding material in the Goliad Sand, Lissie Formation, Beaumont Clay, and the alluvium. The permeable beds are hydraulically connected so they function as a unit. In southeastern Starr County, the zone of permeable material in the alluvium does not extend more than 2 mi north of the Rio Grande, and the bottom of the permeable material is about 50 ft below land surface. In Hidalgo County, the width of the permeable material ranges from near 0 to about 5 mi and the bottom of the permeable material ranges from about 75 ft below land surface on the western side of the county to approximately 185 ft on the eastern side. In Cameron County, the area underlain by the permeable material may extend as far as 10 mi north of the river and the bottom of the permeable zone may be as much as 250 ft below land surface, although most water is withdrawn from wells about 200 ft deep.

The Mercedes-Sebastian shallow aquifer consists of permeable deposits of clay that are less than 100 ft below the land surface in southeastern Hidalgo County, western Cameron County, and southwestern Willacy County. The permeable deposits appear to be in a northeast-trending channel, which may have been a former course of the Rio Grande during the Pleistocene. The lateral extent of the aquifer is not well defined.

HISTORY OF MONITORING ACTIVITIES

The U.S. Fish and Wildlife Service has been actively involved in the monitoring of contaminants in the lower Rio Grande valley for approximately 20 years. In 1967, a fish-sampling station was established on the Rio Grande near Mission as part of the National Contaminant Biomonitoring Program. Every 2 or 3 years, composite samples of representative predator and bottom-feeding fish species have been collected at this station to monitor concentrations of organochlorine pesticides and trace elements. Fish sampled at this location have consistently contained some of the larger concentrations of DDT, DDE, and toxaphene recorded in the United States. During 1976, 1978 and 1979, the U.S. Fish and Wildlife Service collected fish from the Arroyo Colorado adjacent to the Laguna Atascosa National Wildlife Refuge (White and others, 1983). Large concentrations of DDE and toxaphene were detected in samples collected from near McAllen to near Rio Hondo. DDE concentrations as large as 31.5 µg/g wet weight were detected in a whole-fish composite sample of channel catfish, and toxaphene concentrations as large as 3.15 µg/g wet weight were detected in a whole-fish composite sample of blue catfish.

White and others (1983) also reported large concentrations of DDE in birds collected from several locations in the lower Rio Grande valley--specifically near a wide and shallow part of the Main Floodway north of Progresso, the mouth of the Arroyo Colorado, and the mouth of the Raymondville Drain. DDE concentrations, wet weight, in laughing gulls (Larus *atricilla*) ranged from 5 to 71 µg/g, 5 to 41 µg/g, and 2 to 81 µg/g in each of these respective areas. Ring-billed gulls (*L. delawarenis*), Franklin's gull (*L. pipixcan*), pied-billed grebe (*Podilymbus podiceps*), Forster's tern (*Sterna forsteri*), great-tailed grackles (*Quiscolus mexicanus*), and red-winged blackbirds (*Agelaius phonecius*) collected in the vicinity of Progreso contained DDE concentrations ranging from 2 to 37 µg/g wet weight. Toxaphene concentrations in birds were small throughout the areas, ranging from nondetectable to 3 µg/g wet weight.

Andreasen (1985) reported that mosquito fish (*Gambusia affinis*) from the lower Rio Grande valley developed a genetic resistance to toxaphene. He reported that mosquito fish collected from this area were 122 times more resistant to toxaphene than control fish. He emphasized the ecological consequences of this phenomenon, especially in terms of biomagnification by predatory species that may result in adverse effects or death as a consequence of ingesting toxaphene-resistant prey.

In the early 1980's, the U.S. Fish and Wildlife Service contracted with the Oklahoma State University Cooperative Research Unit to sample bed sediments and biota in the Laguna Atascosa National Wildlife Refuge and the Laguna Madre, and to analyze these samples for minor elements and pesticides. Much of these data have not been formally released to the U.S. Fish and Wildlife Service; however, selenium data have been released and are included in a report published by the U.S. Fish and Wildlife Service (1986). Selenium concentrations in the liver of gizzard shad were reported to be as large as 4,600 and 6,300 µg/kg dry weight in samples from Laguna Atascosa and Cayo Atascoso, respectively.

During the summer of 1985, the U.S. Fish and Wildlife Service sampled approximately 95 locations in the lower Rio Grande valley for minor elements and pesticides in bed sediments. Many of these sites were located in the Laguna Atascosa National Wildlife Refuge. Although these data have not been published, a summary of some of these data is included in this report.

Limited minor-element and pesticide data are available from the U.S. Geological Survey. These data have been collected at the Rio Grande at Brownsville (station 08475000) as part of the National Stream Quality Accounting Network (NASQAN) program. Minor-element data collected between 1976-85 indicate that concentrations of arsenic, cadmium, lead, and mercury have not exceeded the U.S. Environmental Protection Agency's (1976) maximum contaminant levels for public water supplies. Organochlorine and organophosphorus pesticide data collected by the U.S. Geological Survey and analyzed by the U.S. Environmental Protection Agency indicate that concentrations of most pesticides in water samples have been less than or only slightly larger than detection limits. Analysis for pesticides of two bed-sediment samples collected from Arroyo Colorado near Mercedes, Texas (station 08470300) in 1981 indicated concentrations of chlordane ranging from 1 to 7 μg/kg and concentrations of DDE ranging from 11 to 34 μg/kg.

An examination of data obtained from the Texas Water Commission for selected minor elements and pesticides in water, bed sediments, and biota indicate few problems with these constituents in whole-water samples. Large concentrations of these constituents were not detected in the bed sediments from the Rio Grande or the Laguna Madre. Large concentrations of arsenic and lead were detected in bed sediments from a limited number of samples collected from Arroyo Colorado. For example, concentrations of arsenic in 11 bed-sediment samples collected from Arroyo Colorado near Harlingen during 1976-85 ranged from 3.7 to 71 mg/kg and concentrations of lead ranged from 14 to 36 mg/kg at this same location. During 1975-76, concentrations of toxaphene in biota tissue from eight samples at this location ranged from 2.4 to 2,196 μg/g wet weight.

SAMPLE COLLECTION AND ANALYSIS

Objectives

The sampling strategy for the reconnaissance investigation was to collect samples of water, bed sediment, and biota at about 15 sites in the lower Rio Grande valley including the Laguna Atascosa National Wildlife Refuge, and to analyze these samples for selected minor elements and selected pesticides. At four of the sampling sites, additional water samples were collected for gas chromatographic/mass spectrometric (GC/MS) analysis. Measurements of dissolved oxygen, water temperature, specific conductance, and pH were made at the time of water-sample collection. In addition to the sampling in June 1986, three sites were sampled for analysis of pesticides in water during substantial runoff in August 1986. The location of the sampling sites is shown in figures 3 and 4 and a list of the types of analyses performed on samples collected at each site is given in table 1. Data collected during this reconnaissance investigation are presented in tables 22-25 at the end of this report.

Table 1.--Sampling sites and types of analyses of samples

Number and name of sampling site	Water		Bed sediments		Biota	
	Minor elements	Pesti-cides	Minor elements	Pesti-cides	Minor elements	Pesti-cides
1. International Falcon Reservoir	X	X	X		X	X
2. Rio Grande above Anzalduas Dam	X	X	X		X	X
3. Main Floodway near Progreso	X	X	1/ X		X	X
4. Arroyo Colorado above Rio Hondo	X	X	1/ X			
5. Arroyo Colorado near mouth of old channel	X	X	1/ X		X	X
6. Resaca de los Cuates at State Highway 100 near Russeltown	X	X	X	X	X	X
7. Resaca de los Fresnos at U.S. Highway 77 at San Benito	X	X	X	X	X	X
8. Resaca de los Cuates at Farm Road 106 near Rio Hondo	X	X	X		X	X
9. Cayo Atasco at Farm Road 106 near Rio Hondo	X	X	X		X	X
10. Laguna Atascosa at Laguna Atascosa National Wildlife Refuge	X	X	1/ X		X	X
11. Cayo Atascoso at crossing 1	X	X	X		X	X
12. Cayo Atascoso at crossing 2	X	X	X			
13. Laguna Madre near mouth of Harlingen Ship Channel	X	X	X		X	X
14. Athel Pond	X	X	X	X		
15. Pelican Lake	X	X	X	X		

1/ Sample for gas chromatographic/mass spectrometric analysis also collected at this site.

The sampling site at International Falcon Reservoir was selected to serve as a background site because it is upstream from the major irrigation areas in the lower Rio Grande valley. The sites on the Arroyo Colorado were selected because the arroyo is one of the principal irrigation-return-flow drains in the valley and because it flows through the northern end of the refuge and discharges into Laguna Madre. The sites on Resaca de los Cuates at State Highway 100 near Russeltown and Resaca de los Fresnos at U.S. Highway 77 at San Benito represent headwater areas for the two sources of freshwater inflow to the refuge. The sites on the Cayo Atascoso and Resaca de los Fresnos at Farm Road 106 represent primary inflows to the refuge. The additional sites on the Cayo Atascoso and Laguna Atascosa represent sites on the refuge that receive irrigation drainage. Pelican Lake is a tidally affected, periodically inundated mud flat. Large concentrations of lead, presumably a result of its past use as part of an artillery range, have been detected in water from Pelican Lake. This area receives only limited freshwater inflow and a limited amount of irrigation drainage. Athel Pond is a small pond in the channel of Resaca de los Cuates that receives and holds irrigation drainage. Evaporative losses result in large concentrations of dissolved solids in this small pond.

Sampling Methods

Water samples were collected using depth-integrated procedures described in Guy and Norman (1970). At several sampling sites, water depths or velocities or both were insufficient to use standard sampling procedures. Under these conditions, water was collected in hand-held bottles. All water samples were processed at the sampling sites according to procedures of the U.S. Geological Survey.

Bed-sediment samples were collected using a stainless-steel Eckman dredge. Three bed-sediment samples were collected at each sampling site, cornposited, and sieved through a 62-micrometer sieve prior to sample analysis. The dredge was thoroughly washed with freshwater and rinsed using methyl alcohol and deionized water after each sampling.

Most samples of fish and crabs for tissue analyses were collected using gill nets and traps. All species were identified, labeled, and chilled or frozen at the sampling sites. All samples for biota analyses remained frozen until time of analysis.

Analytical Support

Water samples for minor-element analysis and water and bed-sediment samples for pesticide analysis were analyzed by the U.S. Geological Survey's water-quality laboratory in Denver, Colorado. Radiochemical analysis of water samples was performed by private laboratories under contracts awarded by the U.S. Geological Survey. Bed-sediment samples for minor element analysis were analyzed by the U.S. Geological Survey's geochemistry laboratory in Denver. Analyses of biota samples for minor elements and pesticides were performed by the U.S. Fish and Wildlife Service at the Patuxent Analytical Control Facility, Patuxent Wildlife Research Center, in Laurel, Maryland.

GUIDELINES FOR DETERMINATION OF GREATER THAN

BACKGROUND CONCENTRATIONS OR VALUES

Guidelines to assist study teams in interpreting data from the reconnaissance investigations were prepared by the Committee on Guidelines for Data Interpretation, which was established by the DO1 Task Group on Irrigation Drainage. The guidelines prepared by the committee are initial suggestions on how to interpret the data from the reconnaissance investigations and are not considered official or citeable documents by the DO1 or any bureau within the DOI. They were prepared to assist study teams in determining what constitutes greater than background concentrations of substances associated with irrigation drainage, and to provide some degree of consistency between the nine reconnaisance investigations in making these determinations. The guidelines consisted of the following:

1. Legal standards and recommended criteria for 17 chemical constituents and commonly regulated pesticides.
2. Contaminant residues and biological effects.
3. Baseline concentrations from selected studies of soils in the western conterminous United States.
4. Baseline concentrations in fish based on a national monitoring program.
5. Baseline concentrations in water based on national monitoring programs.

The legal standards and recommended criteria for 17 chemical constituents and commonly regulated pesticides as well as the baseline concentrations in soils, fish, and water were selected to determine if concentrations of constituents detected in the water were potentially harmful to humans, fish, or wildlife. Additional criteria, selected from a report published by the U.S. Environmental Protection Agency (1986) also were used to determine potentially harmful concentrations or properties of water.

The water-quality criteria and standards used in this report are presented in table 2. The derivation of numerical water-quality criteria for the protection of aquatic organisms and their use as food for other species, including humans, is a complex process that uses information from many areas of aquatic toxicology. After a decision is made that a national criterion is needed for a particular constituent all available information concerning toxicity to, and bioaccumulation by, aquatic organisms is collected, reviewed for acceptability, and sorted. If enough acceptable data on acute toxicity to aquatic organisms are available, they are used to estimate the maximum l-hour average concentration that should not result in unacceptable effects on aquatic organisms and their uses. If justified, this concentration is determined as a function of a water-quality property such as pH, salinity, or hardness. Similarly, data on the chronic toxicity of the constituent to aquatic organisms are used to estimate the maximum 4-day average concentration that should not cause unacceptable toxicity during a long-term exposure. If appropriate, this concentration is also related to a water-quality property (U.S. Environmental Protection Agency, 1986).

Table 2.--Water-quality criteria and standards for selected minor elements and organic compounds

[µg/L, micrograms per liter; ng, nanograms; mg, milligrams;
µg, micrograms; pCi/L, picocuries per liter1

Element or compound	Freshwater aquatic-life acute criteria 1/ (µg/L)	treshwater aquatic-life chronic criteria 2/ (µg/L)	Saltwater aquatic-life acute criteria 1/ (µg/L)	Saltwater aquatic-life chronic criteria (µg/L)	Water and fish injection 2/ (units per liter)	Fish consumption only (units per liter)	Primary or secondary standard for public water supplies (µg/L except where noted)
Arsenic	--	--	--		3/ 2.2 ng	3/ 17.5 ng	50
Barium	--		--		1 mg	--	1,000
Cadmium	4/ 3.9	4/ 1.1 --	43	9.3 --	10 µg	--	10
Chromium	16	11	1,100	50	50 µg	--	50
Copper	4/ 18	y 12	2.9	2.9	--	--	1,000
Gross alpha radioactivity	--	--	--	--	--	--	15 pCi/L
Lead	4/ 82	4/ 3.2	140	5.6	50 µg	--	50
Mercury	2.4	.012	2.3	.025	144 µg	146 µg	2
Nickel	4/1,800	4/ 96	140	7.1	13.4 µg	100 µg	
Radium-226	--	--	--	--	--	--	5 pCi/L
Selenium	4/ 260	4/ 35	410	54	10 µg	--	10
Silver	4/ 4.1	4/ .12	2.3	--	50 µg	--	50
Zinc	4/ 320	47	170	58	--	--	5,000
Chlordane	2.4	.0043	.09	.004	.46 µg	3/ .48 µg	--
2,4-D	--	--	--	--	100 µg	--	100
2,4,5-TP	--	--	--	--	10 µg	--	--
DDT	1.1	.001	.13	.001	3/ .024 µg	5/ .24	--
DDD	1.1	--	.13	--	--	--	--
DDE	5/1,050	--	5/14	--	--	--	--
Dieldrin	2.5	.0019	.71	.0019	3/ .071 µg	5/ .076 µg	--
Endosulfan	.22	,056	.034	.0087	74 ug	159 µg	--
Endrin	.18	.0023	.037	.0023	1 ug	--	0.2
Heptachlor	.52	.0038	.053	.0036	3/ .28 µg	3/ .29 µg	--
Lindane	--	--		--	--	--	4
Malathion		.01	--	.01	--	--	--
Parathion		.04		.04	--	--	--
PCBs	2.0	.014	10 --	.03	3/ .079 µg	3/ .079 µg	--
Toxaphene	1.6	.013	.07	--	3/ .71 µg	3/ .073 µg	5

1/ Acute criteria based on maximum 1-hour average concentration that should not result in unacceptable effects on aquatic organisms and their use as food for other species.
2/ Chronic criteria based on maximum 4-day average concentration that should not cause unacceptable toxicity during a long-term exposure.
3/ Human-health criteria for carcinogens reported for three risk levels; value presented is for 10^{-6} risk level.
4/ Hardness dependent criteria (100 milligrams per liter used).
5/ Insufficient data to develop criterium; value presented is the lowest observed effect level.

Where applicable, criteria and standards are listed for both freshwater and saltwater. For the use of the criteria and standards in this report, freshwater has been defined as having a dissolved-solids concentration less than 3,500 mg/L. Some waters in this study area may, at times, have dissolved solids concentrations larger and smaller than 3,500 mg/L, therefore both freshwater and saltwater criteria and standards are referenced.

The reader is cautioned that, in most cases, the concentrations listed for the standards and criteria are generally reported as "total" or "total recoverable". Concentrations of minor elements presented in this study are for "dissolved minor elements. Total or total recoverable concentrations, or both, of minor elements may be much larger than the dissolved concentrations reported.

The geochemical baselines for minor elements in soils in the western conterminous United States (table 3) were prepared from minor-element data of all natural soils west of the 97th meridian within the conterminous United States (Shacklett and Boerngen, 1984). Because these geochemical baselines are based on soil data rather than sediment data, the committee on Guidelines for Data Interpretation noted:

1. If minor-element data for individual sediment samples (fraction samller than or equal to 0.062 millimeter) are within the baseline range of minor-element data for soils, it is reasonable to assume that the sediment samples are not uncommon.

2. If minor-element data for individual sediment samples are outside the baseline range of minor-element data for soils, it is not appropriate to conclude that the sediment samples are uncommon. In these situations, the sediment data only indicate that the minor-element concentrations may be uncommonly large or small.

3. In order to make definite statements, the sediment data need to be compared to a baseline range based on sediment data, not soil data.

The baseline concentrations for selected minor elements in fish are presented in table 4 and those for pesticides in table 5. These tables were prepared from data collected by the U.S. Fish and Wildlife Service as part of its National Contaminant Biomonitoring Program (NCBP), formerly called the National Pesticide Monitoring Program. Data in this program have been collected since 1967. Regarding these baseline concentrations, the Committee on Guidelines for Data Interpretation noted:

1. If appropriate comparisons are possible and concentrations of minor elements and pesticides measured during the reconnaissance investigations are less than or equal to the 85th-percentile concentrations in table 4 or the geometric-mean concentrations in table 5, it is reasonable to state that such concentrations are not greater than background in relation to national baseline concentrations.

2. If concentrations of minor elements and pesticides measured during the reconnaissance investigations exceed the 85th-percentile concentrations in table 4 or the geometric-mean concentrations in table 5, it is reasonable to state that such concentrations are greater than background in relation to national baseline concentrations. Even if concentrations are greater than background in relation to national baseline concentrations, this does not

Table 3.--Geochemical baseline concentrations for minor elements in soils from the western conterminous United States

[Detection ratio, number of samples in which the element was detected in measurable concentrations to number of samples analyzed; GM, geometric mean; GD, geometric deviation; baseline range, expected 95-percent range; µg/g, microgram per gram; ---, not determined]

Minor element, unit of measure	Detection ratio	GM	GD	Baseline range	Measured range
Arsenic, µg/g	728:730	5.5	1.98	1.2-22	<0.1 -97
Barium, µg/g	778:778	580	1.72	200-1 ,700	70-5,000
Berylliun, µg/g	310:778	0.68	2.30	0.13-3.6	<1-15
Boron, µg/g	506:778	23	1.99	5.8-91	x20-300
Cadmiun, µg/g	---	---	---	---	---
Cerium, µg/g	81:683	65	1.71	22-190	<150-300
Chromium, µg/g	778:778	41	2.19	8.5-200	3-2,000
Cobalt, µg/g	698: 778	7.1	1.97	1.8-28	<3-50
Copper, µg/g	778:778	21	2.07	4.9-90	2-300
Gallium, µg/g	767:776	16	1.68	5.7-45	<5-70
Lanthanum, µg/g	462:777	30	1.89	8.4-110	<30-200
Lead, µg/g	712:778	17	1.80	5.2-55	<10-700
Lithium, µg/g	731:731	22	1.58	8.8-55	5.0-130
Manganese, µg/g	777:777	380	1.98	97-1,500	30-5,000
Mercury, µg/g	729: 733	0.046	2.33	0.0085-0.25	x0.01-4.6
Molybdenum, µg/g	57:774	0.85	2.17	0.18-4.0	<3-7
Neodymium, µg/g	120:538	36	1.76	12-110	x70-300
Nickel, µg/g	747:778	15	2.10	3.4-66	<5-700
Scandium, µg/g	685:778	8.2	1.74	2.7-25	<5.0-50
Selenium, µg/g	590: 733	0.23	2.43	0.039-1.4	<0.1-4.3
Strontium, µg/g	778:778	200	2.16	43-930	10-3,000
Thorium, µg/g	195: 195	9.1	1.49	4.1-20	2.4-31
Uranium, µg/g	224:224	2.5	1.45	1.2-5.3	0.68-7.9
Vanadium, µg/g	778:778	70	1.95	18-270	70-500
Ytterbium, µg/g	754-754	2.6	1.63	0.98-6.9	<1-20
Yttrium, µg/g	759-778	22	1.66	8.0-60	<10-150
Zinc, µg/g	766:766	55	1.79	17-180	10-2,100

Table 4.--Baseline concentrations of minor elements in fish
[Concentrations in micrograms per gram, wet weight]

Minor element and collection period	Geometric mean	Minimum	85th percentile	Maximum
Arsenic				
1978-79	0.16	0.04	0.23	2.08
1980-81	0.14	0.05	0.22	1.69
Cadmium				
1978-79	0.04	0.01	0.09	0.41
1980-81	0.03	0.01	0.06	0.35
Copper				
1978-79	0.86	0.29	1.14	38.75
1980-81	0.68	0.25	0.90	24.10
Lead				
1978-79	0.19	0.10	0.32	6.73
1980-81	0.17	0.10	0.25	1.94
Mercury				
1978-79	0.11	0.01	0.18	1.10
1980-81	0.11	0.01	0.18	0.77
Selenium				
1978-79	0.46	0.09	0.70	3.65
1980-81	0.47	0.09	0.71	2.47
Zinc				
1978-79	25.63	7.69	46.26	168.10
1980-81	23.82	8.82	40.09	109.21

Table 5.--Baseline concentrations of pesticides in fish

[µg/g, micrograms per gram; NA, not analyzed]

Pesticide	Geometric means in µg/g wet weight		
	1916-f 7	1978-79	1980-81
alpha-BNC	0.02	<0.01	co.01
gamma-BNC	.01	<.01	<.01
cis-Chlordane	.06	.07	.03
trans-Chlordane	.03	.02	.02
Dacthal	NA	.01	<.01
p,p'-DDD	.09	.09	.07
p,p'-DDE	.27	.25	.20
p,p'-DDT	.95	.04	.05
Total DDT 1/	.37	.35	.29
Dieldrin 2/	.05	.05	.04
Endrin	.01	<.01	<.01
Heptachlor 3/	.01	.02	.01
Methoxychlor	NA	NA	<.01
Mirex	NA	NA	<.01
cis-Nonachlor	.01	.03	.02
trans-Nonachlor	.03	.05	.04
Oxychlordane	NA	.01	.01
Toxaphene	.35	.29	.27

1/ p,p'-homologs
2/ May include traces of aldrin for 1976-77.
3/ Includes heptachlor epoxide.

necessarily mean that such concentrations have resulted or will result in adverse biological effects.

Data collected by the U.S. Geological Survey since 1973 as part of the NASQAN and the National Water Quality Surveillance System were used to determine baseline values or concentrations of selected properties and concentrations of selected constituents in water. Percentiles presented in table 6 were determined by calculating the arithmetic-mean value or concentration of each water-quality property or constituent listed for each station and then ranking the means for each property or constituent for the number of stations for which data were available to obtain the 25th, 50th, and 75th percentiles. Mean concentrations denoted as (<) are estimated to be less than the analytical detection limit. Regarding the baseline values and concentrations, the Committee on Guidelines for Data Interpretation noted:

1. Comparisons of values and concentrations measured during the reconnaissance investigations with those in table 6 need to be qualified by the fact that those in the table are not specific for areas sampled during the reconnaissance investigations.
2. If values and concentrations measured during the reconnaissance investigations are less than or equal to the 50th percentile in table 6, it is reasonable to state that such values and concentrations are not greater than background in relation to national values or concentrations.
3. If values and concentrations measured during the reconnaissance investigations are between the 50th and 75th percentiles in table 6, it is reasonable to state that such values and concentrations may be greater than background in relation to national baseline values and concentrations, but additional analysis of the data will be needed before a determination of what constitutes greater than background values and concentrations can be made with reasonable certainty.
4. If values and concentrations measured during the reconnaissance investigations are greater than the 75th percentile in table 6, it is reasonable to state that such values and concentrations are greater than background in relation to national baseline values and concentrations. Even if values and concentrations are greater than background in relation to national baseline values and concentrations, this does not necessarily mean that such values and concentrations have resulted or will result in adverse biological effects.

In addition to using baseline values and concentrations to determine greater than background values and concentrations, boxplots that show the distribution of data were used to determine which values and concentrations were outliers. An example of a boxplot is shown in figure 4. The bottom and top edges of the box are located at the 25th and 75th percentiles; and the center horizontal line is drawn at the 50th percentile (median). It is possible for one or more of these statistics to plot on the same line. The central vertical lines may extend from the box as far as the data extend, but only to a distance of, at most, 1.5 interquartile ranges. (An interquartile range is the distance between the 25th and 75th percentiles.) Any value more extreme than this is marked with an asterisk if it is within 3 interquartile ranges of the box or with a circle if it is outside 3 interquartile ranges of the box. The values marked with a circle commonly are referred to as outliers. The boxplots presented in this report were produced from analytical data that were larger than the lower analytical detection limits.

Table 6.--Baseline values or concentrations of selected properties, major ions, and minor elements in water

[mg/L, milligram per liter; µg/L, microgram per liter]

Water-quality property or constituents	Number of stations	Percentile based on mean data from stations		
		25th	50th	75th
Properties				
pH (units)	290	7.3	7.8	8.1
Dissolved oxygen (mg/L)	369	8.7	9.8	10.5
Alkalinity as $CaCO_3$ (mg/L)	289	42.0	104.3	161.8
Major ions (mg/L)				
Calcium	289	15.8	38.2	66.8
Chloride	289	6.7	14.9	53.3
Magnesium	289	3.9	11.2	21.7
Nitrate, total as N	383	0.20	0.41	0.89
Sodium	289	6.8	18.3	68.9
Sulfate as SO_4	289	10.5	39.9	116.9
Minor elements (µg/L)				
Arsenic	293	<1	1	3
Cadmium	285	<2	<2	<2
Chromium	161	9	10	10
Lead	292	3	4	6
Iron	293	36	63	157
Manganese	286	11	24	51
Mercury	199	0.2	0.2	0.3
Selenium	211	<1	<1	1
Zinc	288	12	15	21

Consequently, some percentile values presented in the boxplots may vary from similar percentile values in the tables of the report. The boxplots are presented in this report to assist in identifying concentrations that may be considered as outliers and larger than background concentrations.

WATER ANALYSES

Minor Elements

Excessive concentrations of minor elements (mostly metals) in a water supply may render the water unsuitable for municipal and domestic uses because of harmful physiological effects. Many minor elements also may be concentrated at successive steps in the aquatic food chain, causing harmful physiological effects in the aquatic organisms and rendering some fish and other aquatic organisms undesirable for human consumption. Dissolved minor elements analyzed in this study along with the analytical detection limit for each element, the number of sampling sites at which each minor element was detected, and the minimum, median, and maximum concentration for each element are listed in table 7. Boxplots of the data for those minor elements which were detected in eight or more samples are shown in figure 5.

The data indicate that concentrations of most dissolved minor elements are relatively small. Median dissolved concentrations of cadmium, chromium, lead, mercury, selenium, and zinc did not exceed the 50th-percentile baseline concentrations listed in table 6. The maximum concentrations of arsenic, cadmium, chromium, mercury, selenium, and zinc exceeded the 75th-percentile baseline concentrations; however, the maximum dissolved concentrations of cadmium, mercury, and selenium exceeded the 75th percentile by only 1 μg/L or less. Larger than average arsenic concentrations are not uncommon in agricultural areas because of the use of arsenic in agricultural practices. The maximum concentration of dissolved chromium, 50 μg/L, was detected in Athel Pond, which receives little, if any, freshwater inflow; concentrations of this constituent, as well as others, may be significantly larger here than at other sampling sites because of evaporation. In fact, the maximum dissolved concentrations of boron, chromium, copper, and zinc were detected in Athel Pond.

There were no baseline concentrations available to assess the concentrations of barium, boron, copper, molybdenum, nickel, silver, or vanadium. Boxplots of those minor elements detected at eight or more sampling sites indicate outliers for boron and nickel. The largest concentrations of dissolved nickel occurred in the Rio Grande at Anzalduas Dam and in the Resaca de los Cuates at State Highway 100 near Russeltown. Concentrations of dissolved nickel at these locations were 18 and 16 μg/L, respectively. All other dissolved nickel concentrations were less than 10 μg/L.

None of the maximum concentrations of dissolved minor elements exceeded the U.S. Environmental Protection Agency's primary and secondary standards for public water supplies, although the maximum concentration of chromium equaled the primary standard for that element. The maximum dissolved concentrations of lead, selenium, silver, and zinc did not exceed the criteria and standards listed in table 2. The maximum concentration of dissolved cadmium exceeded the chronic criteria for freshwater aquatic life in the Cayo Atascoso at crossing number 2 on the Laguna Atascosa National Wildlife Refuge.

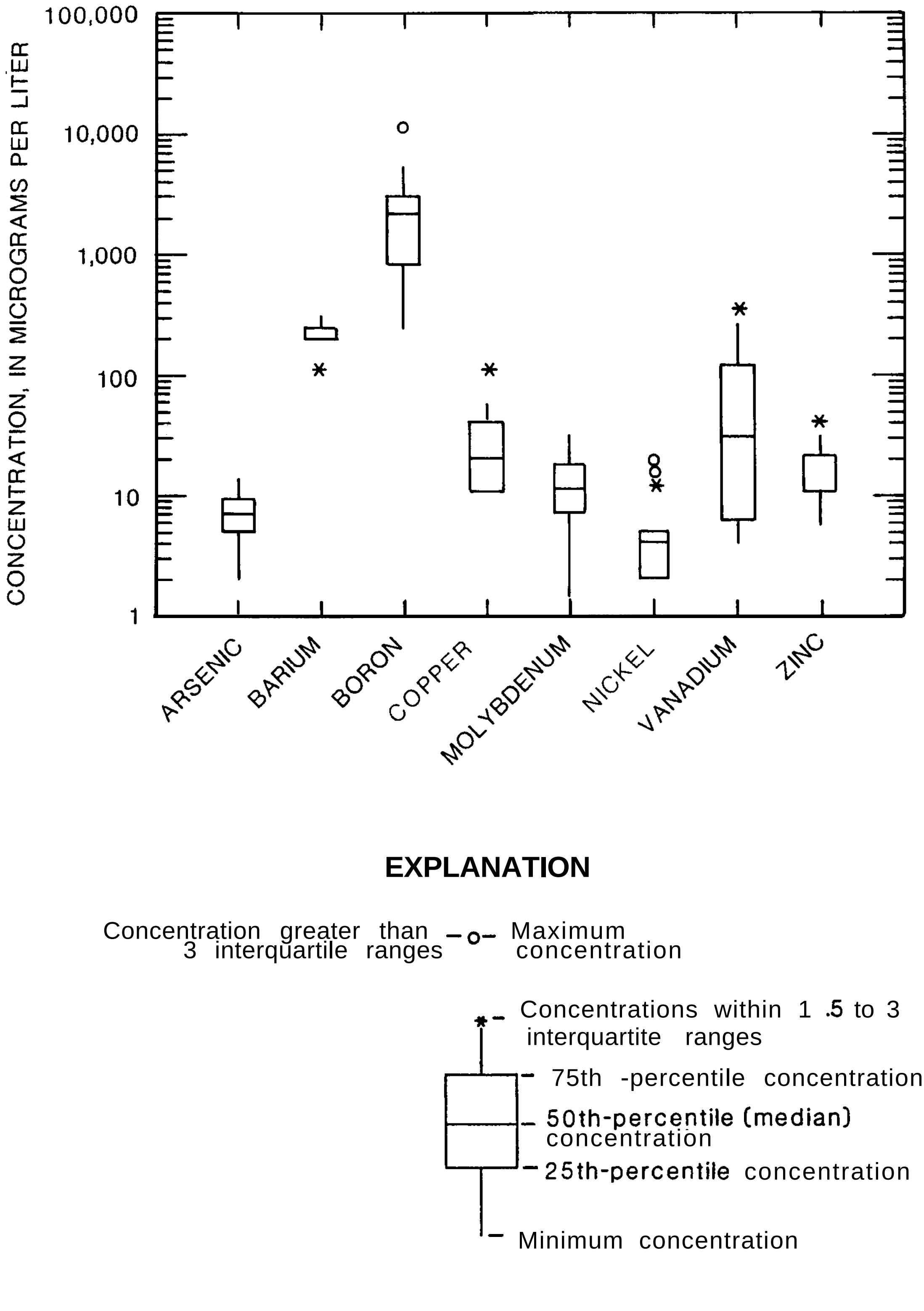


Figure 5.--Boxplots of minor elements detected in eight or more water samples

Table 7.--Statistical summary of minor elements dissolved in water

[µg/L, microgram per liter]

Minor element	Analytical detection limit (µg/L)	Number of sampling sites at which minor element was detected	Concentration (µg/L)		
			Minimum	Median	Maximum
Arsenic	1	15	2	7	14
Barium	100	1/ 8	110	200	300
Boron	100	15	220	2,100	11,000
Cadmium	1	5	<1	<1	2
Chromium	10	5	<10	<10	50
Copper	10	12	<10	20	110
Lead	5	0	<5	<5	<5
Molybdenum	1	15	1	11	33
Mercury	0.1	3	<0.1	<0.1	0.5
Nickel	1	15	1	4	18
Selenium	1	5	<1	<1	2
Silver	1	0	<1	<1	<1
Vanadium	1	2/ 10	4	16	350
Zinc	10	9	<10	10	40

1/ Only analyzed for in 8 samples because of excessive salinity.
2/ Only analyzed for in 10 samples because of excessive salinity.

Concentrations of dissolved copper exceeded the acute and chronic criteria for saltwater aquatic life at 12 sampling sites. The largest concentrations of dissolved copper occurred in the refuge and the Laguna Madre. Chromium exceeded the acute and chronic criteria for freshwater aquatic life at four sampling sites in the refuge and in the Laguna Madre. Chromium also exceeded the chronic criteria for saltwater aquatic life in Athel Pond. All three detectable concentrations of mercury exceeded the chronic criteria for freshwater and saltwater aquatic life. Dissolved nickel exceeded the chronic criteria for saltwater aquatic life in the Rio Grande at Anzalduas Dam and in the Resaca de los Cuates near Russeltown. It is doubtful that saltwater aquatic organisms exist at either of these locations. Although the concentrations of most minor elements are relatively small, all minor element concentrations that exceeded the acute or chronic criteria or both for freshwater or saltwater aquatic life or both have the potential to produce unacceptable effects to aquatic organisms and their use as food.

Concentrations of dissolved boron increased substantially from west to east, indicating that irrigation return flows may be contributing to increased dissolved boron concentrations (fig 6). The smallest concentration of dissolved boron, 220 µg/L, was detected in International Falcon Reservoir. Concentrations of dissolved boron exceed the U.S. Environmental Protection Agency's (1986) criteria of 750 µg/L for long-term irrigation at 12 of the 15 sampling sites. In the Arroyo Colorado drainage, concentrations increased from 840 µg/L at Main Floodway near Progreso to 2,100 µg/L in the Arroyo Colorado above Rio Hondo and near the mouth of the old Arroyo Colorado channel. Dissolved-boron concentrations also increased in the Resaca de los Fresnos-Cayo Atascoso drainage. Concentrations increased from 460 µg/L in the Resaca de los Fresnos at U.S. Highway 77 near San Benito, to 5,300 µg/L near the mouth of the Cayo Atascoso at crossing number 2 in the Laguna Atascosa National Wildlife Refuge. Dissolved-boron concentrations also increased in the Resaca de los Cuates from 440 µg/L at State Highway 100 near Russeltown to 2,200 µg/L at the Farm Road 106 crossing. The largest concentration of dissolved boron, 11,000 µg/L, occurred in Athel Pond.

Boron concentrations greater than 1,000 µg/L are not uncommon in ground water in the lower Rio Grande valley. Baker and Dale (1961) reported concentrations greater than 1,000 µg/L in much of the Linn-Faysville aquifer, in the lower Rio Grande aquifer in western Cameron County, and in much of the Goliad Sand in northern Hidalgo and Willacy Counties. It is beyond the scope of this report to determine whether the increasing concentrations of boron from west to east in the study area are the result of natural dissolution of boron from soils in the area or if irrigation-return flows are at least partly responsible for the increase in boron in the study area.

Dissolved-copper concentrations also increased slightly from west to east, indicating that irrigation return flows may be contributing to concentrations of dissolved copper (fig. 6). Increasing concentrations of copper are of concern because copper is known to be particularly toxic to algae and mollusks (National Academy of Sciences, and National Academy of Engineering, 1973).

Table 8.--Summary of herbicide concentrations in water

[µg/L, micrograms per liter]

Herbicide	Analytical detection limit (µg/L)	Number of sampling sites at which herbicide detected	Maximum concentration (µg/L)
	Chlorophenoxy herbicides		
Silvex	0.01	0	<0.01
2,4-D	0.01	0	co.01
2,4,5-TP	0.01	0	<0.01
	Triazine herbicides		
Ametryne	0.1	0	<0.1
Atrazine	0.1	6	0.8
Cyanazine	0.1	0	<0.1
Perthane	0.1	0	<0.1
Prometone	0.1	1	1.7
Prometryne	0.1	0	<0.1
Propazine	0.1	0	<0.1
Simazine	0.1	2	0.6
Simetryne	0.1	0	<0.1
	Other		
Dicamba	c.01	7	0.05
Picloram	0.01	1	0.01

Table 9.--Summary of concentrations of organochlorine insecticides and other selected chlorinated hydrocarbon compounds in water

[µg/L, micrograms per liter]

Insecticide or compound	Analytical detection limit (µg/L)	Number of sampling sites at which insecticide or compound detected	Maximum concentration (µg/L)
Aldrin	0.01	0	<0.01
Chlordane	.1	0	<.1
DDD	.01	0	<.01
DDE	.01	2	.01
DDT	.01	0	<.01
Dieldrin	.01	0	<.01
Endosulfan	.01	0	<.01
Endrin	.01	0	<.01
Ethion	.01	0	<.01
Heptachlor	.01	0	<.01
Heptachlor epoxide	.01	0	<.01
Lindane	.01	0	<.01
Methoxychlor	.01	0	<.01
Mirex	.01	0	<.01
Toxaphene	1	0	<1
Polychlorinated biphenyls	.1	0	<.1
Polychlorinated napthalenes	.1	0	<.1

Table 10.--Summary of organophosphorus insecticide concentrations in water

[µg/L, micrograms per liter]

Insecticide	Analytical detection limit (µg/L)	Number of sampling sites at which insecticide detected	Maximum concentration (µg/L)
Diazinon	0.01	2	0.26
Malathion	.01	3	.71
Methyl parathion	.01	8	.75
Methyl trithion	.01	0	<.01
Parathion	.01	0	<.01
Trithion	.01	0	<.01

from 0.03 to 0.26 µg/L. The maximum concentrations of all three of the organophosphorus insecticides were detected in the Main Floodway near Progreso.

Carbamate pesticides analyzed for include methomyl, propham, and sevin. The analytical detection limit for the carbamate insecticides is 2.0 µg/L. No carbamate pesticides were detected in any of the samples.

In addition to pesticide samples collected during the June sampling, three time-weighted composite pesticide samples were collected during August 5-7, 1986, following heavy precipitation in the area. Pesticide samples were collected at the two inflow points to the refuge--Resaca de los Cuates at Farm Road 106 and Cayo Atascoso at Farm Road 106. The third sample was collected in Arroyo Colorado above Rio Hondo. Dicamba was the only pesticide detected in Resaca de los Cuates at Farm Road 106. The concentration of dicamba at this sampling site was 0.03 µg/L. Water was not flowing in this resaca during this sampling period because control gates kept the water ponded upstream from the farm road.

Several pesticides were detected in the Arroyo Colorado above Rio Hondo during the runoff sampling. Simazine, atrazine, and prometone were the triazine herbicides detected and maximimum concentrations of these compounds were 0.30, 0.20 and 0.1 µg/L, respectively. A chlorophenoxy herbicide, 2,4,-D, was detected at a concentration of 0.13 ug/L, which is significantly less than the standard of 100 mg/L for public water supplies (table 2). Picloram and dicamba, both chlorinated herbicides, were detected at concentrations of 0.01 and 0.05 µg/L, respectively. DDE, an organochlorine insecticide, was detected at a concentration of 0.01 µg/L, which is less than the acute criteria for freshwater and saltwater aquatic life given in table 2. Diazinon, malathion, and methyl parathion, all organophosphorus insecticides, were detected at concentrations of 0.07, 0.05, and 0.01 µg/L, respectively.

In the Cayo Atascoso at Farm Road 106, which is the principal inflow to the refuge, the only herbicides detected were 2,4-D and dicamba. These herbicides were detected at concentrations of 0.13 and 0.04 µg/L, respectively. The organochlorine insecticide DDE was detected at a concentration of 0.01 µg/L, and the organophosphorus insecticide methyl parathion was detected at a concentration of 0.09 µg/L.

These limited data indicate that pesticides detected during periods of runoff were similiar to those detected during base flow. The only exception was that the herbicide 2,4-D was detected during runoff.

Other Organic Compounds

In addition to pesticide analyses, four l-gallon water samples were collected for GC/MS analysis. The purpose of these samples was to analyze for industrial or agricultural organic compounds in the water which would not readily be detected in the pesticide analyses. Compounds specifically analyzed for include the acid- and base/neutral-extractable compounds listed in table 11. Samples for GC/MS analyses were collected at the Main Floodway near Progreso, Arroyo Colorado above Rio Hondo, Arroyo Colorado near mouth of old channel, and Laguna Atascosa at Laguna Atascosa National Wildlife Refuge. None of the compounds listed in table 11 were detected in any of the four

Table 11.--List of acid- and base/neutral-extractable compounds and their analytical detection limits

[μg/L, micrograms per liter]

Compound	Analytical detection limit (μg/L)
Acid-extractable	
1. 4-Chloro-3-methylphenol	30
2. 2-Chlorophenol	5
3. 2,4-Dichlorophenol	5
4. 2,4-Dimethylphenol	5
5. 2,4-Dinitrophenol	20
6. 4,6-Dinitro-2-methylphenol	30
7. 2-Nitrophenol	5
8. 4-Nitrophenol	30
9. Pentachlorophenol	30
10. Phenol	5
11. 2,4,6,Trichlorophenol	20
Base/neutral-extractable	
12. Acenaphthene	5
13. Acenaphthylene	5
14. Anthracene	5
15. Benzo (a) anthracene	5
16. Benzo (b) fluoranthene	10
17. Benzo (k) fluoranthene	10
18. Benzo (g,h,i) perlyene	10
19. Benzo (a) pyrene	10
20. 4-Bromophenyl phenyl ether	5
21. Rutyl benzyl phthalate	5
22. bis (2-Chloroethoxy) methane	5
23. bis (2-Chloroethyl) ether	5
24. bis (2-Chloroisopropyl) ether	5
25. 2-Chloronaphthalene	5
26. 4-Chlorophenyl phenyl ether	5
27. Chrysene	10
28. Dibenzo (a,h) anthracene	10
29. 1,2-Dichlorobenzene	5
30. 1,3-Dichlorobenzene	5
31. 1,4-Dichlorobenzene	5
32. Diethyl phthalate	5
33. Dimethyl phthalate	5
34. Di-n-butyl phthalate	5
35. 2,4-Dinitrotoluene	5
36 2,6-Dinitrotoluene	5
37. Di-n-octyphthalate	10
38. bis (2-Ethylhexyl) phthalate	5
39. Fluoranthene	5
40. Fluorene	5
41. Hexachlorobenzene	5

Table 11.--List of acid- and base/neutral-extractable compounds and their analytical detection limits--Continued

Compound	Analytical detection limit (µg/L)
Base/neutral-extractable--Continued	
42. Hexachlorobutadiene	5
43. Hexachlorocyclopentadiene	5
44. Hexachloroethane	5
45. Indeno (1,2,3-cd) pyrene	10
46. Isophorone	5
47. Naphthalene	5
48. Nitrobenzene	5
49. n-Nitrosodimethylamine	5
50. n-Nitrosodi-n-propylamine	5
51. n-Nitrosodiphenylamine	5
52. Phenanthrene	5
53. Pyrene	5
54. 1,2,4-Trichlorobenzene	5

water samples. However, the following compounds and their concentrations were detected at the four sampling sites:

Compound	Concentration (micrograms per liter)
Main Floodway near Progreso	
1. Anthraquinone	0.08
2. n-Butyl-n-nitroso-1-butanamine	0.18
3. 2,5-Cyclohexadiene-1,4-dione	0.19
4. 1-Phenylethanone	0.17
5. Phosphoric acid, tributyl ester	0.20
6. Unknown hydrocarbon	1.49
7. Unknown hydrocarbon	3.69
8. Unknown hydrocarbon	3.56
9. Unknown hydrocarbon	8.94
Arroyo Colorado above Rio Hondo	
1. 4-Methyl-benzenesulfonamide	0.42
2. Triidomethane	0.19
3. Unknown hydrocarbon	0.32
Arroyo Colorado near mouth of old channel	
1. Tetradecanoic acid	0.51
2. Unknown hydrocarbon	1.62
Laguna Atascosa at Laguna Atascosa National Wildlife Refuge	
1. 2,5-Cyclohexadiene-14-dione	0.17
2. Unknown hydrocarbon	0.12

Radiochemical Analyses

Radiochemical analyses consisted of dissolved uranium, radium 226, and gross alpha radioactivity. Concentrations of dissolved uranium ranged from less than 0.4 μg/L as uranium to 41 μg/L with a median concentration of 4.1 μg/L. The largest concentration of dissolved uranium was detected in Pelican Lake, which receives little freshwater inflow except from precipitation and local runoff. Radium-226 was detected at 13 sampling sites. Detectable concentrations ranged from less than 0.1 to 0.5 pCi/L (picocuries per liter), and had a median concentration of 0.2 pCi/L. Five picocuries per liter is the standard for public water supplies (table 2). Two sampling sites had detectable concentrations of gross-alpha radioactivity. International Falcon Reservoir had a concentration of 9.2 μg/L as uranium-natural. In a set of duplicate samples collected in Arroyo Colorado above Rio Hondo, one sample had a concentration of 34 μg/L and the other was reported as less than 49 μg/L as uranium-natural. Fifteen picocuries per liter is the standard for public water supplies. Assumming all the gross-alpha radioactivity is due to natural uranium and assumming that the uranium is in equilibrium, the concentrations of natural uranium in micrograms per liter can be converted to picocuries per liter by multiplying the concentration in micrograms per liter by 0.68.

BED-SEDIMENT ANALYSES

Minor Elements

A summary of the analytical results of minor elements in bed sediments is presented in table 12. Boxplots showing the distribution of selected minor elements are presented in figure 7. The data indicate that, with the exception of manganese, concentrations of these minor elements in the study area are within the baseline concentrations for soils in the western conterminous United States. The largest concentrations of manganese in bed sediments observed in the study area occurred in the Arroyo Colorado below Rio Hondo and in the Cayo Atascosa at Farm Road 106 near Rio Hondo.

An examination of boxplots of the minor elements detected in more than one sample of bed sediments indicates few outliers in the data. Outliers are noted for manganese, strontium, cerium, lanthanum, neodymium, and ytterbium. The largest concentrations of manganese were 1,300 μg/g detected in the Arroyo Colorado above Rio Hondo, and 1,600 μg/g detected in the Cayo Atascosa at Farm Road 106 near Rio Hondo. The largest concentration of strontium, 670 μg/g, was detected in Athel Pond. The largest concentrations of cerium, lanthanum, and neodymium were all detected in International Falcon Reservoir.

Summaries of minor-elements in bed sediments collected at 95 locations throughout the lower Rio Grande valley in July and August 1985 by the U.S. Fish and Wildlife Service are presented in table 13 and figure 8. A comparison of these data with the data collected in 1986 is not valid in all cases because different analytical procedures were used in the two studies. The data collected during 1985 indicate that maximum concentrations of boron, lead, manganese, strontium, and zinc exceed the baseline concentrations presented in table 3. The 75th-percentile concentrations for all of these constituents are well within the baselines. Boxplots of the data indicate outliers for arsenic, barium, boron, copper, lead, manganese, strontium, vanadium, and zinc. The large number of outliers detected in this study can be attributed to the large number of samples collected and to the fact that the minor elements are not uniformly distributed in the environment.

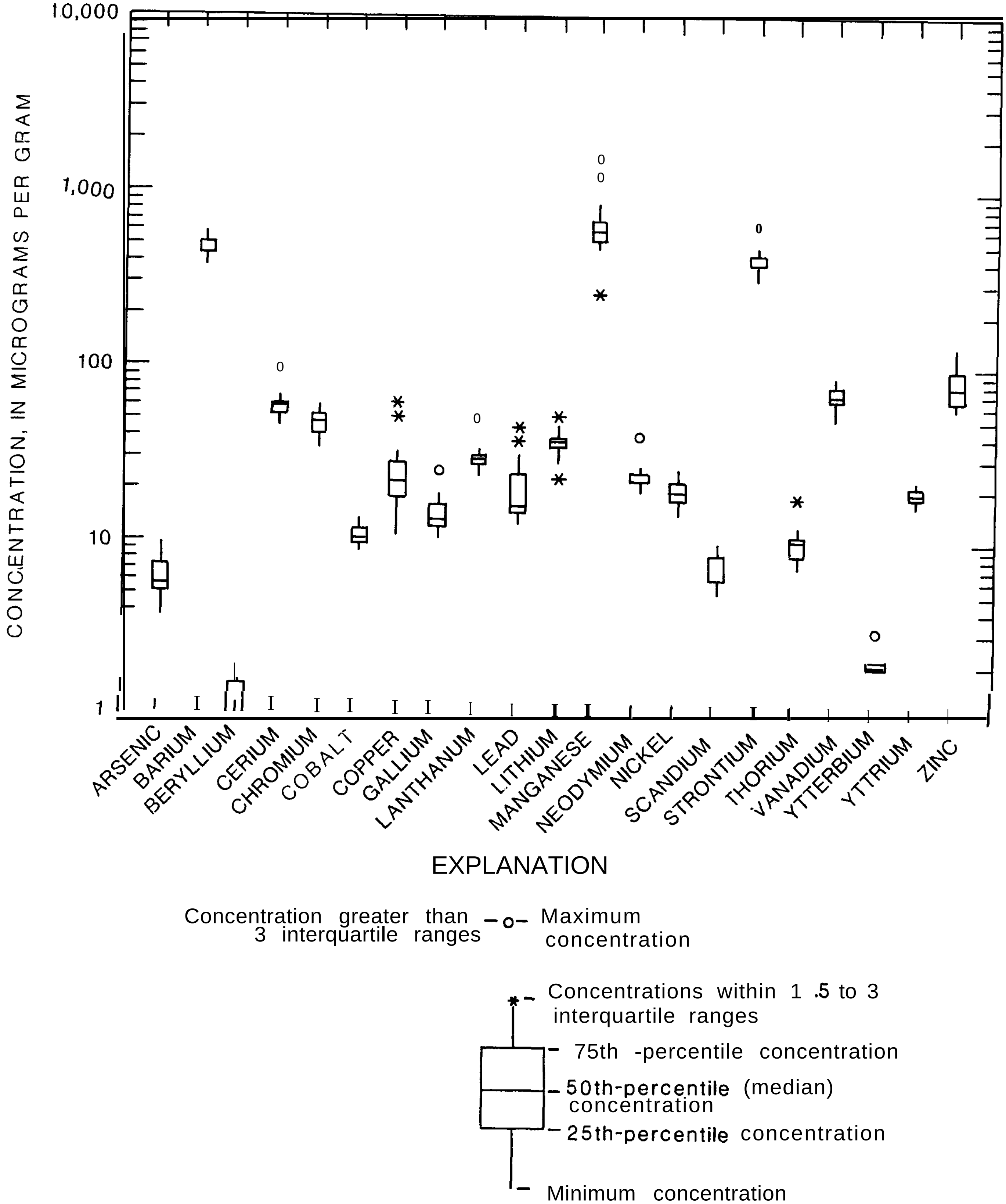
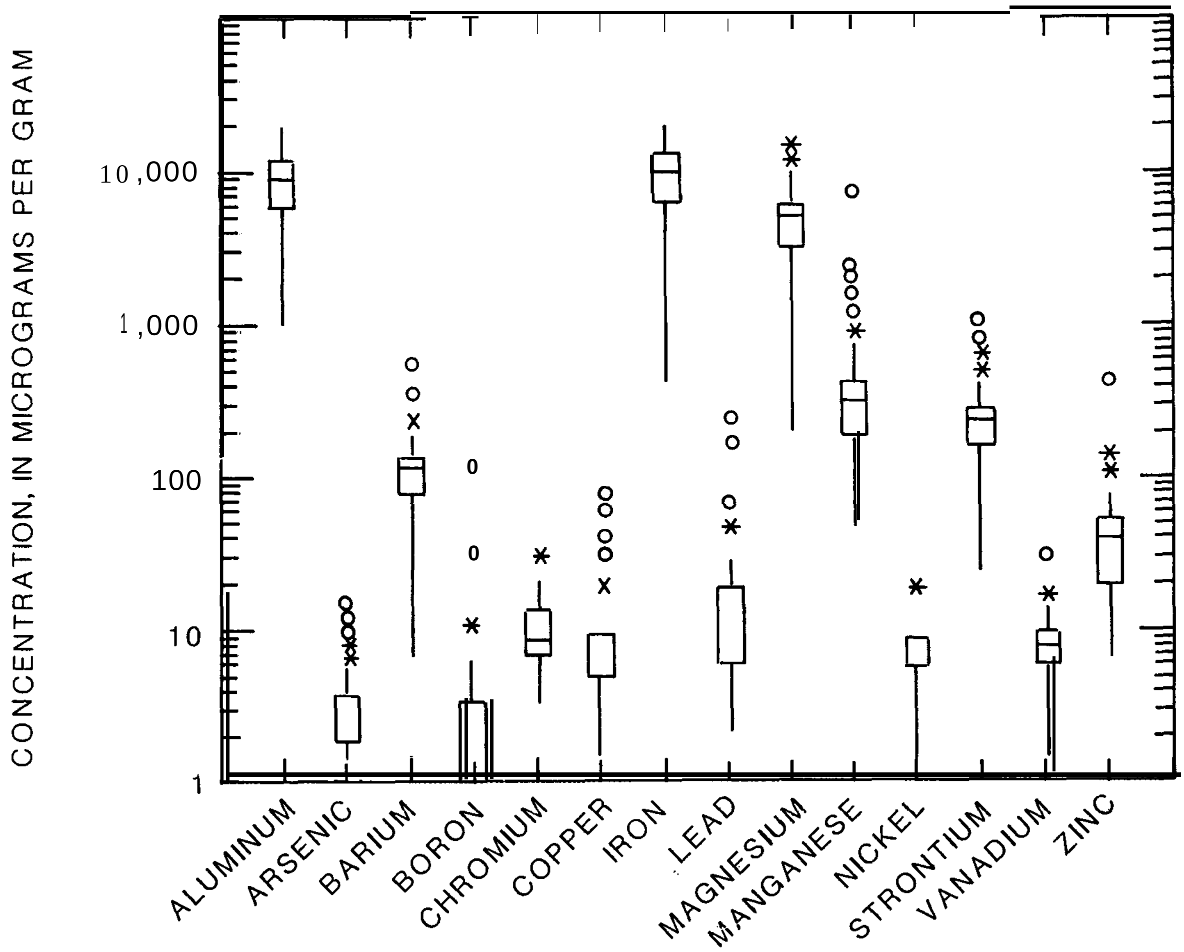


Figure 7.--Box plots of selected minor elements in bed sediments collected in June, 1986



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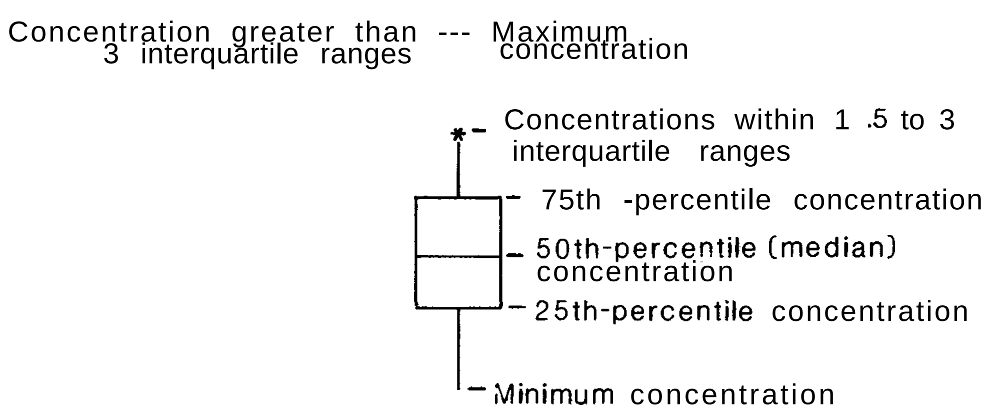


Figure 8.--Box plots of selected minor elements in bed sediments collected in July and August 1985

Table 12.--Statistical summary of minor elements in bed sediments collected in June 1986

[µg/g, micrograms per gram]

Minor element	Analytical detection limit (µg/g)	Number of sampling sites at which minor element detected	Concentration (µg/g) Minimum	Median	Maximum
Arsenic	0.1	15	3.7	5.4	9.4
Barium	100	15	350	470	580
Beryllium	1	14	<1	1	2
Bismuth	10	0	<10		<10
Boron	1	14	0.8	-4.0	12
Cadmium	2	0	<2	--	<2
Cerium	4	15	[illegible]	56	95
Chromium	1	15	[illegible]	42	57
Cobalt	1	15	9	10	13
Copper	1	15	10	21	61
Europium	2	0	<2	--	<2
Gallium	4	15	11	14	18
Gold	8	0	<8	--	<8
Holmium	4	0	<4	--	<4
Lanthanum	10	15	25	29	51
Lead	10	15	13	16	45
Lithium	2	15	24	37	51
Manganese	4	15	280	620	1,600
Molybdenum	2	1	<2	<2	2
Neodymium	10	15	19	23	40
Nickel	[illegible]	15	15	18	25
Scandium	1	15	5	6	10
Selenium	0.1	15	0.3	0.4	0.7
Silver	2	0	<2	--	<2
Strontium	2	15	320	440	670
Tantalum	40	0	<40	--	<40
Thorium	10	15	7	10	17
Tin	100	0	<10	--	<10
Uranium		0	<100	--	<100
Vanadium	10	15	49	60	82
Ytterbium	1	15	2	2	3
Yttrium	10	15	17	19	22
Zinc	10	15	59	75	130

Table 13. --Statistical summary of minor elements in bed sediments collected during July and August 1985

[µg/g, micrograms per gram; ND, not detected]

Minor element	Minimum	25 percentile	5c percentile	75 percentile	Maximum
	(µg/g)				
Aluminum	940	5,600	8,700	12,000	20,000
Arsenic	1	2	3	4	15
Barium	6	77	120	140	560
Boron	ND	ND	ND	4	110
Chromium	ND	7	9	11	32
Copper	ND	5	10	10	70
Iron	350	5,700	9,100	12,000	18,000
Lead	ND	6	10	20	240
Magnesium	185	3,100	5,000	6,100	12,700
Manganese	37	180	310	440	7,300
Nickel	ND	6	9.5	10	20
Strontium	20	170	250	310	1,140
Vanadium	1	6	8	10	31
Zinc	6	20	40	57	440

Insecticides

Because of monetary restrictions, bed-sediment samples for insecticide analysis were collected at only four sampling sites in the study area. These sites were locations not sampled in the summer of 1985 by the U.S. Fish and Wildlife Service. Sampling sites for pesticide analyses were Resaca de los Fresnos at U.S. Highway 77 at San Benito, Resaca de los Cuates at State Highway 100 near Russeltown, Athel Pond, and Pelican Lake. A summary of the pesticide analyses in bed sediments is presented in table 14.

Chlordane, DDE, DDD, DDT, and dieldrin were the organochlorine insecticides detected in the study area. DDE was detected at all four sampling sites with concentrations ranging from 0.2 to 34 µg/kg. DDE was detected at concentrations of 0.2 and 0.5 µg/kg in Pelican Lake and Athel Pond. No other organochlorine insecticides were detected in bed sediments on the refuge. The maximum concentration of DDE was detected at Resaca de los Cuates at State Highway 100 near Russeltown. DDD also was detected at this sampling site at a concentration of 2.3 µg/kg. Chlordane, DDD, DDE, DDT, and dieldrin were all detected at Resaca de los Fresnos at U.S. Highway 77 at San Benito. Concentrations of these compounds were 4.0, 9.7, 9.3, 7.3, and 0.1 µg/kg, respectively. Both the Resaca de los Cuates and Resaca de los Fresnos are the primarv freshwater inflow into the Laauna Atascosa National Wildlife Refuge. No organophosphorus insecticides, polychlorinated biphenyls, or polychlorinated napthalenes were detected in the bed sediments.

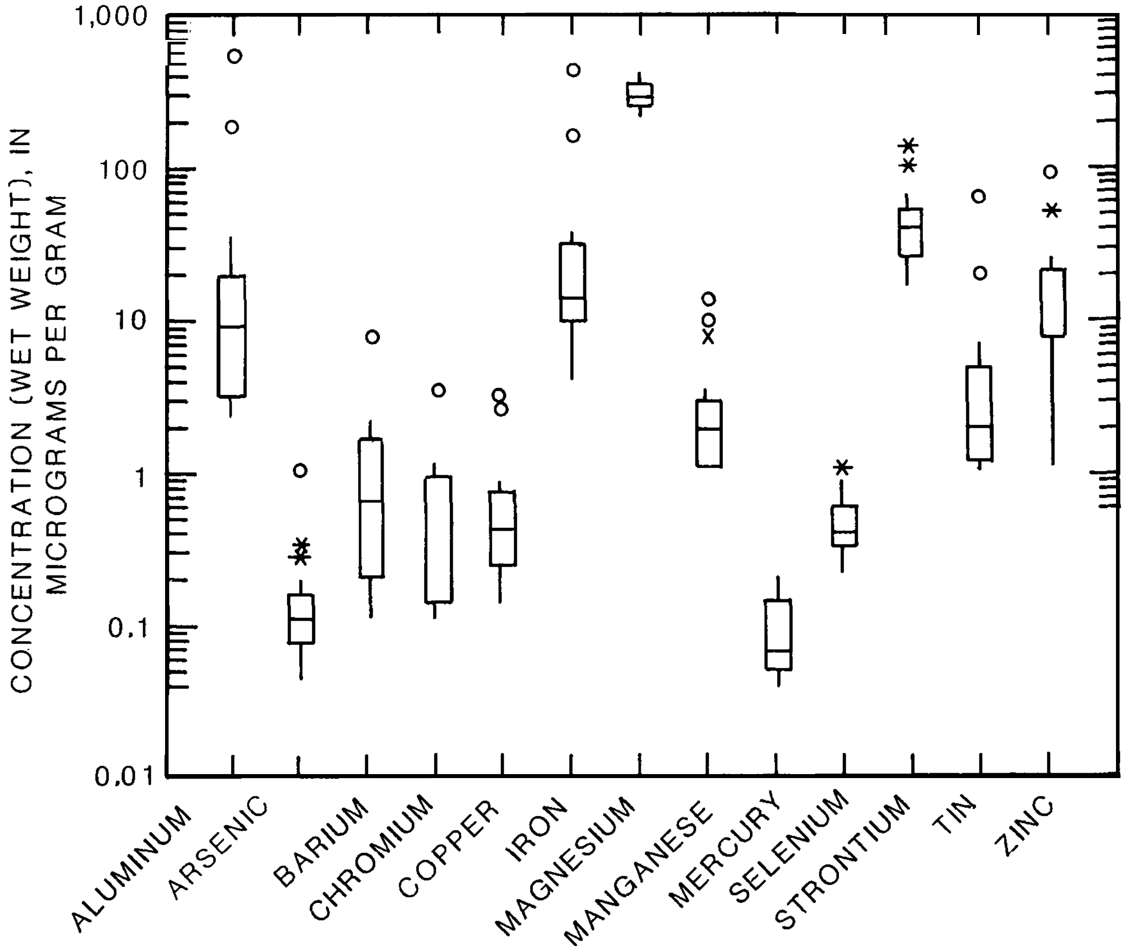
Results from this limited number of samples are in close agreement with organochlorine-insecticide data collected the previous year by the U.S. Fish and Wildlife Service. Their study determined concentrations of DDE ranging from less than the analytical detection limit to 6.0 µg/g. That study detected DDE in about 75 percent of the samples. The median DDE concentration in that study was 0.01 µg/g. Both studies indicate that DDE is widespread in bed sediments in the lower Rio Grande valley. Although no baseline concentrations are available for DDE or other organochlorine insecticides in bed sediments, the widespread nature of DDE in bed sediments are of concern because of the possibility of uptake and bioaccumulation in the food chain.

BIOTA ANALYSES

Minor Elements

Chemical interactions of minor elements in aquatic environments can be complex. Although not fully understood, minor elements can undergo synergistic, or antagonistic interactions that result in changes in toxicity to biota. Consequently, little or no information on criteria guidelines have been established for concentrations of minor elements in fish and wildlife. It was an objective of this reconnaissance investigation to determine whether minor elements that may pose a threat to reproduction and survival are present in biota.

A summary of minor elements detected in fish is presented in tables 15 and 16. The data indicate that the maximum concentrations of arsenic, copper, mercury, selenium, and zinc exceeded the 85th-percentile concentrations listed in table 4. Cadmium and lead were not detected in fish. None of the median concentrations exceeded the 85th-percentile concentrations listed in table 4. Boxplots (fig. 9) for the minor elements listed in table 4 indicate that the



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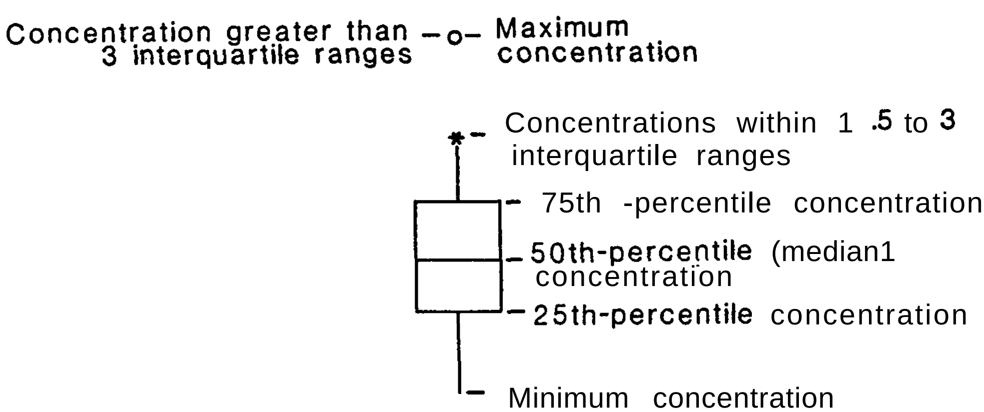

Figure 9.--Box plots of selected minor elements detected in 10 or more fish

Table 14.--Summary of organochlorine and organophosphorus insecticides and selected chlorinated hydrocarbon compounds in bed sediments

Lug/kg, micrograms per kilogram]

Insecticide or compound	Analytical detection limit (µg/kg)	Number of sampling sites at which insecticide or compound detected	Maximum concentration (µg/kg)
	Oganochlorine insecticides		
Aldrin	0.1	0	<1.0
Chlordane	1.0	1	4.0
DDD	.1	2	9.7
DDE	.1	4	34
DDT	.1	1	.2
Dieldrin	.1	1	.2
Endosulfan	.1	0	<.1
Endrin	.1	0	<.1
Ethion	.1	0	<.1
Heptachlor	.1	0	<.1
Heptachlor epoxide	.1	0	<.1
Lindane	.1	0	<.1
Methoxychlor	.1	0	<.1
Mirex	.1	0	<.1
Toxaphene	10	0	<10

Table 14.--Summary of organochlorine and organophosphorus insecticides and selected chlorinated hydrocarbon compounds in bed sediments--Continued

Insecticide or compound	Analytical detection limit (µg/kg)	Number of sampling sites at which insecticide or compound detected	Maximum concentration (µg/kg)
	Organophosphorus insecticides		
Malathion	0.1	0	<0.1
Parathion	0.1	0	<0.1
Diazinon	0.1	0	<0.1
Methyl parathion	0.1	0	<0.1
Trithion	0.1	0	<0.1
Methyl trithion	0.1	0	<1.0
Perthane	1.0	0	<1
	Compounds		
Polychlorinated biphenyls	1	0	<1
Polychlorinated napthalenes	1.0	0	<1.0

Table 15.--Statistical summary of minor elements in fish

[µg/g, micrograms per gram; ND, not detected]

Minor element	Analytical detection limit (µg/g, wet weight)	Number of samples in which minor element was detected	Concentration (µg/g) Mini-mum	Median	Maxi-mum
Aluminum (dry)	--	21	9	35	2,300
(wet)	1	21	2.3	9.0	530
Arsenic (dry)	--	19	ND	.40	5.2
(wet)	.05	19	ND	.10	1.0
Garium (dry)	--	21	.29	1.8	34
(wet)	.1	21	.10	.61	7.9
Geryllium (dry)	--	0	ND	--	ND
(wet)	.1	0	ND	--	ND
Coron (dry)	--	5	ND	ND	28
(wet)	5	5	ND	ND	6.3
Cadmium (dry)	--	0	ND	--	ND
(wet)	.1	0	ND	--	ND
Chromium (dry)	--	11	ND	ND	14
(wet)	.1	11	ND	ND	3.4
Copper (dry)	--	20	ND	1.3	11
(wet)	.1	20	ND	.34	3.0
Iron (dry)	--	20	ND	58	1,700
(wet)	1.0	20	ND	13	400
Lead (dry)	--	0	ND	--	ND
(wet)	.1	0	ND	--	ND
Magnesium (dry)	--	20	ND	1,100	1,500
(wet)	1.0	20	ND	250	360
Manganese (dry)	--	15	ND	6.4	53
(wet)	1.0	15	ND	1.8	13
Mercury (dry)	--	12	ND	ND	.87
(wet)	.05	12	ND	ND	.20
Molybdenum (dry)	--	1	ND	ND	1.7
(wet)	1.0	1	ND	ND	.39
Nickel (dry)	--	1	ND	ND	.44
(wet)	.1		ND	ND	.15
Selenium (dry)	--	2:	.59	1.7	3.4
(wet)	.05	22	.19	.38	.95
Strontium (dry)	--	21	67	140	440
(wet)	.1	21	15	38	120
Tin (dry)	--	16	ND	7.8	260
(wet)	1.0	16	ND	1.7	61
Vanadium (dry)	--	10	ND	ND	3.9
(dry)	.1	10	ND	ND	.91
Zinc (dry)	--	20	ND	43	230
(wet)	1.0	20	ND	9.6	85

Table 16.--Minor element concentrations in ffsh

[µg/g, micrograms per gram; --, not determined1

Species	Site	Concentration fug/g wet weight) Alumi-num	Ar-se-nfc	Bo-ron	Barium	Beryl-lium	Cad-mfum	Chro-mium	Cop-per	Iron	Mag-ne-sfum	Man-w nese	Mer-cury	Mo-lyb-denum	Nick-el	Lead	Sele-nfum	Stron-tium	Tin	Vana-dium	Zinc
Gizzard shad	1	530	0.27	<5.0	7.9	<0.099	x0.099	0.63	0.18	400	360	13	co.041	<0.099	--	<0.20	0.41	48	61	0.91	6.4
Gizzard shad	2	14	.10	<4,8	1.9	<.097	<.097	.12	.29	21	230	1.8	<.042	<.097	--	<.20	.56	23	2.5	.15	6.5
Gizzard shad	3	190	.09	<4.9	1.6	<.097	<.097	.35	.14	150	330	7.5	<.049	<.097	--	<.19	.19	23	19	.41	6.1
Gizzard shad	5	la	.15	<4.9	.69	<.098	<.098	.45	.35	26	290	1.6	.04	<.098	--	<.20	.37	26	3.5	.14	10
Carp	1	19	.04	5.0	2.1	x.096	<.096	1.1	.65	35	290	1.4	<.046	<.096	--	<.19	.52	48	4.8	.13	51
Carp	2	9.2	.04	5.7	.89	<.099	<.099	<.099	.81	19	240	<.099	<.041	<.099	--	<.20	.50	24	2.0	<.989	49
carp	10	3.0	.13	<4.8	.19	<.097	<.097	<.097	.71	13	250	1.1	.05	<.097	<.097	<.19	.63	66	1.7	.14	25
Freshwater drum	10	2.3	.29	<4.8	.33	<.097	<.097	<.097	.42	3.9	230	1.8	.06	<.097	<.097	<.19	.57	50	< .19	<.097	7.6
Channel catfish	2	2.3	<.045	6.3	.22	<.099	<.099	<.099	.12	9.3	240	<.99	<.038	<.099	--	<.19	.33	20	< .99	<.099	9.6
Channel catfish	2	20	.09	<4.8	.38	<.095	<.095	.11	.25	13	210	<.95	.04	<.095	--	<.19	.33	15	1.0	.11	10
Blue catfish	9	6.8	.11	<4.9	.14	<.097	<.047	<.097	.19	12	210	1.8	.11	<.097	<.097	<.19	.38	25	1.5	<.097	11
Blue catfish	10	3.1	.I2	4.9	.14	<.097	<.097	<.097	.47	6.8	250	2.6	.06	<.097	<.097	<.19	.38	43	< .97	c.97	9.6
Blue catfish	10	3.0	.12	<4.8	.13	x.096	x.096	.15	.23	10	210	3.3	.oa	<.097	<.097	<.19	.22	35	1.5	<.96	8.0
Sea catfish		13	1.0	5.3	.1	<.098	<.098	<.098	<.098	<.098	<.098	<.098	.16	<.098	--	<.20	.57	24	5.1	<.098	.98
Sea catfish	1:	2.3	.30	<4.8	.64	<.097	<.097	<.097	.66	11	330	2.8	.20	.39	<.087	<.19	.37	50	1.2	.16	85
Tilapia species	6	10	<.042	5.0	.55	<.099	<.099	3.4	.42	26	260	6.8	.06	<.099	--	<.20	.27	36	4.0	.18	1.0
Sheepshead minnow	6		.07	--	--	--	--		--	--	--	--	<.099	--	--	--	.35	--	--	--	--
Sheepshead minnow	8	27	<.042	<5.0	2.2	<.10	<.10	.94	3.0	34	360	13	<.045	<.10	--	<.20	.30	120	4.8	.28	15
Gulf killfffsh	8	9.0	.07	<5.0	.a9	<.099	<.099	.93	.81	15	360	9.4	.04	<.099	--	<.20	.30	95	2.0	<.099	25
Largemouth bass	1	3.0	.05	<4.8	.44	<.045	<.095	<.095	.23	6.7	310	<.95	<.040	<.095	--	<.19	.87	34	< .95	<.095	8.7
Striped bass (hybrid)	1	3.3	.09	<5.0	.84	<.10	<.10	<.10	2.4	7.0	300	<.10	<.048	<.10	--	<.20	.95	38	<1.0	<.10	11
Alligator gar	9	5.5	.11	<4.8	.61	<.096	<.096	.23	.34	13	360	1.8	.20	<.096	.15	<.19	.28	55	1.6	<.096	7.2

maximum concentrations of arsenic, copper, and zinc are outliers and may not be representative of concentrations in the lower Rio Grande valley. The largest concentration of arsenic in fish was detected in a gizzard shad from the Arroyo Colorado near the mouth of the old channel. The largest concentration of copper in fish was detected in a sheepshead minnow from Resaca de los Cuates at Farm Road 106. The largest concentration of zinc in fish was detected in a sea catfish from Laguna Madre.

Although national-baseline concentrations are not available for other minor elements in fish, boxplots of the data (fig. 9) indicate no outliers for manganese, magnesium, or strontium, indicating that the data may be representative of concentrations in the lower Rio Grande valley. This does not mean that the data would or would not be representative when compared to nationwide data. Two outliers were noted for aluminum, copper, iron, manganese, and tin and one outlier was noted for arsenic, barium, chromium, and zinc. The largest concentrations of aluminum, barium, iron, manganese, and tin, and one outlier for copper in fish were measured in fish from International Falcon Reservoir. This reservoir stratifies during the summer and minor elements may be released from the bed sediments in deep parts of the lake and incorporated into the food chain. The additional outliers for aluminum, iron, and tin were measured in fish from the Main Floodway near Progreso. The additional outliers for copper and manganese were measured in fish from Resaca de los Cuates at the inflow to the Laguna Atascosa National Wildlife Refuge. The largest concentration of arsenic was measured in fish taken from the Arroyo Colorado near the mouth of the old channel. The largest concentrations of chromium and zinc were measured in fish from the Resaca de los Cuates near Russeltown, and the Laguna Madre near the mouth of the Harlingen Ship Channel, respectively.

The largest concentration of selenium, 0.95 μg/g wet weight, was measured in a striped bass from the International Falcon Reservoir. Bauman and May (1984) have suggested that selenium concentrations greater than 2.0 μg/g wet weight may result in conditions which cause reproductive impairment and lack of recruitment in fishes. Analytical results for selenium concentration in biota of the lower Rio Grande valley indicate that selenium does not appear to pose a threat to fish and wildlife population, nor do selenium concentrations exceed guidelines known to cause physiological and reproductive impairment.

Minor elements measured in softshell turtles are listed in table 17. Arsenic, beryllium, boron, cadmium, chromium, lead, molybdenum, and vanadium were not detected. Concentrations of aluminum, barium, copper, iron, manganese, mercury, nickel, selenium, strontium, tin, and zinc do not appear to be at concentrations that are cause for concern. Whether the concentrations of mangesium (170 to 320 μg/g wet weight) are greater than background or should be of concern, has not been determined at this time.

Minor elements measured in whole samples in blue crabs also are listed in table 17. Aluminum, arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, tin, vanadium, and zinc either were not detected or were at concentrations that are not of concern. Blue crabs contain some of the largest concentrations of boron measured in this investigation (5.2 to 9.7 μg/g wet weight). These concentrations are not unusual for marine organisms because boron tends to concentrate in calcareous structures more readily than other tissues (Phillips and Russo, 1978).

Table 17.--Minor element concentrations in softshell turtles and blue crabs
[µg/g, micrograms per gram; --, not determined]

Species	Site	Concentration (µg/g, wet weight)																			
		Alu-mf-num	Ar-se-nfc	Bo-ron	Bar-fum	Beryl-lfum	Cad-mfum	Chro-mfum	Cop-per	Iron	Mag-ne-sium	Man-ga-nese	Mer-cury	Mo-lyb-denum	Nfc -el	Lead	Sele-nfum	Stron-tium	Tin	Vana-dium	Zinc
Softshell turtle	1	15	<0.047	<4.9	2.2	<0.098	<0.098	<0.098	0.24	18	290	<0.095	<0.042	<0.095	--	<0.20	0.38	55	2.2	x0.095	16
Softshell turtle	2	27	<.045	<4.9	1.3	<.097	<.098	<.098	.43	31	210	1.2	.06	<.098	--	<.19	.30	29	4.7	<.098	14
Softshell turtle	3	16	<.047	<4.9	.57	<.099	<.099	<.099	.20	<.099	170	4.2	.08	<.099		<.20	.17	17	1.5	<.099	13
Softshell turtle	6	51	<.048	<5.0	1.8	<.099	<.099	<.099	.32	58	170	2.4	.06	<.099		<.20	.19	24	8.5	<.099	9.8
Softshell turtle	7	18	<.047	<4.7	4.4	<.095	<.095	<.095	.21	23	280	1.1	.08	<.095		<.19	.25	68	2.8	<.095	'15
Softshell turtle	8	22	<.046	<4.7	2.3	<.095	<.095	<.095	.21	21	320	3.1	.06	<.095		<.19	.15	130	3.0	<.095	16
Softshell turtle	9	31	<.094	<4.9	1.0	x.098	<.098	<.098	.43	49	310	3.2	.07	<.098	0.63	<.20	<.044	110	6.9	<.098	16
Blue crab	5	2.9	.28	5.9	.1	<.098	<.098	<.098	<.098	<.098	<.098	<.098	.08	<.098		<.20	.20	25	6.3	x.098	<.098
Blue crab	9	76	1.2	9.7	9.7	<.095	<.098	<.098	12	40	360	32	.07	<.098	--	<.19	.21	290	5.5	<.098	12
Blue crab	11	70	1.1	9.2	5.7	<.097	<.097	<.12	16	60	510	54	.05	.37	<.097	<.19	.22	310	3.5	<.098	6.3
Blue crab	11	42	1.1	5.5	3.3	<.097	<.097	<.097	9	25	510	25	.05	.25	<.097	<.19	.26	160	3.9	.12	8.7
Blue crab	13	48	1.1	5.2	.1	<.097	<.097	<.097	.45	39	290	15	.06	.097	<.097	<.19	.32	230	6.2	<.097	21

Copper generally is not toxic to humans, but additional information is needed to determine if the maximum concentrations of magnesium and strontium (510 and 310 µg/g, respectively) measured in blue crabs may be harmful if consumed by humans.

Concentrations of minor elements measured in a single composite whole sample of five black-necked stilts and in two composite samples of the algae *Chara* sp. from Laguna Atascosa are listed in table 18. Although the minor-element data are difficult to interpret, it would appear that copper, strontium, and zinc concentrations may be greater than background in the black-necked stilt sample. Arsenic and strontium concentrations also may be greater than background in the *Chara* samples. *Chara* has been characterized as an important food item in waterfowl diets (Martin and others, 1951). A detailed understanding of the minor-element concentrations detected and the possible effects these concentrations may have on wintering waterfowl is needed for the Laguna Atascosa National Wildlife Refuge and the nearby Laguna Madre.

Insecticides

A summary of concentrations of organochlorine insecticides and related compounds in fish is presented in tables 19 and 20. DDD, DDE, DDT, and toxaphene were the only organochlorine insecticides detected.

Toxaphene was detected in 11 fish samples with concentrations ranging from 0.98 to 5.1 µg/g wet weight. The maximum and median concentrations of toxaphene exceeded the 1980-81 baseline concentrations (table 5). A composite sample of gizzard shad from the Arroyo Colorado contained the maximum concentration of toxaphene while a composite sample of alligator gar from the Cayo Atascoso at Highway 106 showed 4.9 µg/g wet weight. Concentrations of toxaphene have decreased compared to concentrations measured in the late 1970's (White and others, 1983). Eisler and Jacknow (1985) concluded that concentrations of toxaphene ranging from 0.4 to 5.0 µg/g wet weight were harmful to fish species. Mayer and Mehrle (1977) reported a similar range of toxaphene concentrations dause poor growth and bone development in brook trout, fathead minnows, and channel catfish. With the banning of toxaphene in recent years, concentrations of toxaphene in the environment are expected to decrease.

Maximum concentrations of DDD, DDE, and DDT and median concentrations of DDE were larger than the national baseline concentrations (table 5). DDD was detected in 21 fish samples with concentrations ranging from 0.015 to 0.16 µg/g wet weight. DDE was detected in all fish samples collected and concentrations ranged from 0.36 to 9.9 µg/g wet weight. The maximum concentrations of DDD and DDE were measured in the same composite sample of gizzard shad from the main Floodway near Progreso that also contained the maximum concentration of toxaphene. DDT was detected in 11 fish samples with concentrations ranging from 0.021 to 0.066 µg/g wet weight. The maximum DDT concentration was measured in the composite sample of alligator gar from the Cayo Atascoso. The maximum concentrations of DDD and DDT exceeded the 1980-81 baseline, while both maximum and median levels of DDE exceeded the baseline concentrations (table 3).

Table 18.--Minor-element concentrations in black-neck stilt and *Chara* algae species composite samples

[µg/g, micrograms per gram1

Minor element	Concentration (µg/g wet weight)		
	Black-necked stilt composite	*Chara* algae species composite	*Chara* algae species composite
Aluminum	8.7	450	430
Arsenic	.16	1.8	2.1
Barium	1.2	4.5	5.4
Beryllium	x.099	<.098	<.097
Boron	7.7	7.9	11.0
Cadmium	<.099	<.098	<.097
Chromium	.14	.73	.89
Copper	1.4	.57	.45
Iron	36	190	230
Lead	.93	<.20	.35
Magnesium	220	370	370
Manganese	1.1	35	54
Mercury	.27	x.030	<.038
Molybdenum	<.099	<.098	<.097
Nickel	<.099	.24	.29
Selenium	.47	.057	<.046
Strontium	19	110	130
Tin	5.3	29	35
Vanadium	<.099	.88	.64
Zinc	17	<.98	<.47

Table 19.--Statistical summary of concentrations of organochlorine insecticides and selected chlorinated hydrocarbon compounds in fish

[µg/g, micrograms per gram; ND, not detected]

Insecticide or compound	Analytical detection limit (µg/g wet weight)	Number of samples in which insecticide or compound detected	Concentration (µg/g) Minimum	Median	Maximum
cis-Chlordane (dry)	--	0	ND		ND
(wet)	0.01	0	ND		ND
trans-Chlordane (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
p,p'-DDD (dry)	--	21	ND	0.095	0.55
(wet)	.01	21	ND	.022	.18
p,p'-DDE (dry)	--	22	0.15	1.5	31
(wet)	.01	22	.036	.38	9.9
p,p'-DDT (dry)	--	11	ND	.075	.24
(wet)	.01	11	ND	.021	.066
Dieldrin (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
Endrin (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
Heptachlor Epoxide (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
cis-Nonachlor (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
trans-Nonachlor (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
Oxychlordane (dry)	--	0	ND		ND
(wet)	.01	0	ND		ND
Toxaphene (dry)	--	11	ND	4.5	16
(wet)	.5	11	ND	.98	5.1
Polychlorinated biphenyl-1254 (dry)	--	2	ND	ND	.35
(wet)	.1	2	ND	ND	.11

Table 20.--Organochlorine insecticide concentrations and lipid fraction in fish

[µg/g, micrograms per gram1

Species	Site	Lipid (per-cent)	p,p'-DDD (µg/g wet weight)	p,p'-DDE (µg/g wet weight)	p,p'-DDT (µg/g wet weight)	Toxaphene (µg/g wet weight)
Gizzard shad	1	0.95	0.016	0.036	<0.0097	<0.48
Gizzard shad	2	1.51	.039	.77	.035	1.1
Gizzard shad	3	10.98	.18	9.9	.054	5.1
Gizzard shad	5	7.11	.036	.56	.030	3.5
Carp	1	2.82	x.0099	.17	x.0099	<.50
Carp	2	3.27	.032	.35	.026	1.0
Carp	10	1.52	.017	.27	<.0099	<.49
Freshwater drum	10	4.97	.015	.24	< .0097	<.49
Channel catfish	2	4.49	.079	3.0	.055	2.2
Channel catfish	2	4.66	.044	1.5	.037	1.6
Blue catfish	9	2.26	.061	2.0	.038	2.2
Blue catfish	10	2.73	.021	.38	.024	1.3
Blue catfish	10	7.53	.053	1.6	.038	2.3
Sea catfish	5	.84	.018	.29	< .0098	.98
Sea catfish	13	1.30	.015	.30	<. 0098	<.49
Tilapia species	6	3.21	.020	.16	< .0099	<.50
Sheepshead minnow	6	4.45	.027	.19	x.025	<1.3
Sheepshead minnow	8	2.79	.022	.27	< .0098	<.49
Gulf killifish	8	1.89	.015	.38	<.0096	<.48
Largemouth bass	1	6.22	.018	4.0	< .0095	<.48
Striped bass (hybrid)	1	4.31	.020	.35	.021	<.49
Alligator gar	9	7.34	.16	5.8	.066	4.9

The composite sample of five black-necked stilts contained concentrations of DDD, DDE, and DDT of 0.053, 3.3, and 0.036 μg/g wet weight, respectively. The concentration of DDE is small compared to that measured in other bird species from the lower Rio Grande valley in 1978 (White and others, 1983). Those concentrations ranged from 0.3 to 81 μg/g wet weight. No toxaphene was detected. Little can be determined from the concentrations of DDD, DDE, and DDT in a single composite sample other than documentation of the continued bioaccumulation of these insecticides in the food chain.

Two samples of an algae (*Chara* sp.) from the Laguna Atascosa also were analyzed for insecticides. Only DDT at a concentration of 0.077 μg/g wet weight was detected. The importance of this single concentration cannot be determined.

Organochlorine-insecticide data for tissue samples from softshell turtles are listed in table 21. DDE was measured in all seven samples and toxaphene was measured in five of the samples. DDE concentrations ranged from 0.35 to 9.1 μg/g wet weight whereas toxaphene concentrations ranged from less than the analytical detection limit to 7.1 μg/g wet weight. These concentrations are as large as those measured in fish tissue.

Softshell turtles are found throughout the drainage ditches, resacas, and arroyos in the lower Rio Grande valley and are top predators in many of these habitats. As such, they have bioaccumulated organochlorine insecticides to levels that may be of concern. Softshell turtles are harvested along with other turtles in the lower Rio Grande valley as biological specimens and for human consumption. As DDD, DDE, DDT, and toxaphene concentrations decrease in the valley, as indicated by historic concentrations in fish, these contaminants also are expected to decrease in softshell turtles.

Organochlorine insecticides measured in blue crabs (Callinectes sapidus) also are listed in table 21. DDE was measured in all five samples and ranged from 0.074 to 1.1 μg/g wet weight. Toxaphene was not detected. Lipid percentages in blue crabs are less than 1 percent, so large concentrations of organochlorine insecticides are not expected to accumulate in blue crabs.

The widespread occurrence of DDT and its metabolites, DDD and DDE, and toxaphene in fish, bird, turtle, crab, and plant tissue indicates that these insecticides, most of which also were detected in the bed sediments, are being incorporated into the food chain. Although available data are not sufficient to determine if these concentrations may be hazardous to human health or to biota, people need to at least be aware of their presence.

SUMMARY

During the last several years, there has been increasing concern about the quality of irrigation drainage and its potential effects on human health, fish, and wildlife. Members of Congress, Federal and State agencies, and several environmental organizations have requested information from the DO1 about irrigation projects and facilities constructed or managed by the DOI. In 1985, the DO1 formed an interagency group to evaluate the quality of irrigation drainage throughout the western United States. As a result, 19 areas were identified that warranted a reconnaissance investigation to assess the effects of irrigation drainwater. In 1986, reconnaissance investigations were

Table 21.--Concentrations of organochlorine insecticides and lipid fractions in softshell turtles and blue crabs

[µg/g, micrograms per gram]

Species	Site	Lipid (percent)	p,p'-DDD µg/g (wet weight)	p,p'-DDE µg/g (wet weight)	p,p'-DDT µg/g (wet weight)	Toxaphene µg/g (wet weight)
Softshell turtle	1	3.90	0.013	0.35	0.021	<0.48
Softshell turtle	2	7.54	.033	2.6	.033	2.1
Softshell turtle	3	3.31	.064	9.1	.045	5.2
Softshell turtle	6	5.72	.026	4.2	.046	7.1
Softshell turtle	7	4.68	.020	1.4	< .0097	1.6
Softshell turtle	8	2.29	.015	.38	<.010	<.50
Softshell turtle	9	3.41	.017	1.6	.037	2.4
	5					
Blue crab	9	.95	.036	1.1	< .0094	<.47
Blue crab		.91	.022	.61	< .0095	<.47
Blue crab	11	.27	<.0094	.074	x.0094	<.47
Blue crab	11	.51	<.0098	.084	< .0098	<.49
Blue crab	13	.35	.012	.080	<.0096	<.48

started in the lower Rio Grande valley specifically in and near the Laguna Atascosa National Wildlife Refuge, and eight other areas to determine from existing information and from the collection of additional data whether irrigation drainage has caused or has the potential to cause harmful effects in human health, fish, and wildlife or may adversely affect the suitability of water for beneficial uses.

Data collected during the reconnaissance investigation of the lower Rio Grande valley and the Laguna Atascosa National Wildlife Refuge indicate that concentrations of dissolved minor elements in water generally are small. The maximum dissolved concentrations of arsenic, cadmium, chromium, mercury, selenium, and zinc in water exceeded the 75th-percentile baseline concentrations developed for the reconnaissance investigations; however, maximum dissolved concentrations of cadmium, mercury, and selenium exceeded the 75th-percentile concentrations by only 1 μg/L or less. The maximum dissolved concentrations of boron, chromium, copper, and zinc in water were detected in Athel Pond, a small pond on the refuge that receives little freshwater inflow except from local runoff.

Concentrations of dissolved boron in water increased substantially from west to east. The smallest concentration of boron, 220 μg/L, was measured in International Falcon Reservoir. In the Arroyo Colorado drainage, dissolved boron concentrations increased from 840 μg/L in the Main Floodway near Progreso to 2,100 μg/L in Arroyo Colorado near Rio Hondo and at the mouth of the old Arroyo Colorado channel near Arroyo City. Concentrations of dissolved boron in Resaca de los Fresnos-Cayo Atascoso drainage increased from 460 μg/L at U.S. Highway 77 at San Benito to 5,300 μg/L near the mouth of the Cayo Atascoso. Dissolved boron concentrations increased in Resaca de los Cuates from 440 μg/L at State Highway 100 near Russeltown to 2,200 μg/L at the Farm Road 106 crossing. The largest concentration of dissolved boron, 11,000 μg/L, was measured in a sample from Athel Pond.

None of the dissolved minor elements exceeded the U.S. Environmental Protection Agency's primary and secondary standards for public water supplies, although the maximum concentration of chromium equaled the primary standard for that element. Dissolved cadmium exceeded the chronic criteria for freshwater aquatic life in Cayo Atascoso on the Laguna Atascosa National Wildlife Refuge. Concentrations of dissolved copper exceeded the acute and chronic criteria for saltwater aquatic life at 12 sampling sites. Chromium exceeded the acute and chronic freshwater criteria at four sampling sites in the refuge and in Laguna Madre. Chromium also exceeded the chronic criteria for saltwater aquatic life in Athel Pond. All three detectable concentrations of mercury exceeded the chronic criteria for freshwater and saltwater aquatic life. Dissolved nickel exceeded the chronic criteria for saltwater aquatic life in the Rio Grande at Anzalduas Dam and at Resaca de los Fresnos near Russeltown. Although the concentrations of most minor elements are relatively small, all minor element concentrations that exceeded the acute or chronic criteria, or both, for freshwater or saltwater aquatic life, or both, have the potential to produce unacceptable effects to aquatic organisms and their use as food.

Pesticides analyzed for in water included the chlorophenoxy and triazine herbicides and the organochlorine, organophosphorus, and carbamate insecticides. No chlorophenoxy herbicides were detected in water during the June

1986 sampling. Atrazine, prometone, and simazine were the only triazine herbicides detected. Atrazine was detected at six sampling sites and detectable concentrations ranged from 0.1 to 0.8 µg/L. DDE was the only organochlorine insecticide detected in water and it was detected at two sampling sites at concentrations of 0.01 µg/L, which is just greater than the analytical detection limit. Three organophosphorus insecticides were detected in water during the June 1986 sampling. Diazinon was detected at two sampling sites at concentrations of 0.03 and 0.26 µg/L. Malathion was detected at three sampling sites and detectable concentrations ranged fom 0.01 to 0.71 µg/L. Methyl parathion was detected at eight sampling sites with concentrations ranging from 0.01 to 0.75 µg/L. The maximum concentrations of all three organophosphorus insecticides were detected in the Main Floodway near Progreso. No carbamate insecticides were detected in water samples.

Three pesticide samples collected in August 1986 indicate that the types of pesticides during runoff were similar to those detected during base flow. The major exception is that the chlorophenoxy herbicide 2,4-D was detected during runoff. Concentrations of atrazine, prometone, and simazine in the Arroyo Colorado above Rio Hondo were 0.20, 0.10, and 0.30 µg/L, respectively. The concentration of 2,4-D at this location was 0.13 µg/L. The concentration of 2,4-D in the Cayo Atascoso at Farm Road 106 near Rio Hondo was 0.11 µg/L, and the concentration of methyl parathion was 0.09 µg/L. DDE and Dicamba were detected at both sampling sites at concentrations less than or equal to 0.04 µg/L.

With the exception of manganese, concentrations of minor elements in bed sediments were within the baseline concentrations for soils in the western conterminous United States. The largest concentrations of manganese in bed sediments were detected in Arroyo Colorado above Rio Hondo and in the Cayo Atascoso at Farm Road 106 near Rio Hondo. Minor-element data collected by the U.S. Fish and Wildlife Service in July and August 1985 at approximately 95 locations throughout the lower Rio Grande valley and Laguna Madre indicate that maximum concentrations of boron, lead, manganese, and strontium in bed sediments exceeded the baseline concentrations for soils in the western conterminous United States. The 75th-percentile concentrations for these minor elements are well within the baseline concentrations established for this reconnaissance investigation.

No organophosphorus insecticides, polychlorinated biphenyls, or polychlorinated napthalene compounds were detected in four bed-sediment samples. Chlordane, DDD, DDE, DDT, and dieldrin were the organochlorine insecticides detected in bed sediments. DDE was detected at all four sampling sites with concentrations ranging from 0.2 to 34 µg/kg. The maximum concentration of DDE in the bed sediments was detected in Resaca de los Cuates at State Highway 100 near Russeltown. Chlordane, DDD, DDE, DDT, and dieldrin were all detected in Resaca de los Fresnos at U.S. Highway 77 at San Benito. Concentrations of these compounds were 4.0, 9.7, 9.3, 7.3, and 0.1 µg/kg, respectively. Data collected by the U.S. Fish and Wildlife Service during July and August 1985 indicated that DDE was detected in approximately 75 percent of the samples collected. The maximum concentration detected in that study was 6.0 µg/L, and the median concentration was 0.01 µg/g.

Minor-element data for fish indicate that the maximum concentrations of arsenic, copper, mercury, selenium, and zinc exceeded the 85th-percentile baseline concentrations. None of the median concentrations exceeded the baseline concentrations. Boxplots of the data indicate that the maximum concentrations of arsenic, chromium, copper, and zinc are outliers and may not be representative of concentrations in the lower Rio Grande valley. Outliers also were noted for aluminum, barium, iron, manganese, and tin. The maximum concentrations of these elements in fish were from specimens collected from International Falcon Reservoir. This reservoir stratifies in the summer, and minor elements may be released from the bed sediments in the deep parts of the reservoir and incorporated into the food chain.

Concentrations of toxaphene detected in 11 fish samples ranged from 0.98 to 5.1 μg/g wet weight. DDT was detected in 11 fish samples with concentrations ranging from 0.021 to 0.066 μg/g, wet weight. DDD was detected in 21 of 22. fish samples and concentrations ranged from 0.015 to 0.16 μg/g wet weight. DDE was detected in all fish samples collected and concentrations ranged from 0.36 to 9.9 μg/g, wet weight. The maximum concentrations of DDD and DDT exceeded the 1980-81 baseline concentrations. The median and maximum concentrations of DDE and toxaphene exceeded the 1980-81 baseline concentrations. The largest concentrations of DDD, DDE, and toxaphene in fish tissue were all measured in samples collected from the Main Floodway near Progreso. The largest concentration of DDT in fish was measured in a sample collected from Cayo Atascoso at Farm Road 106 near Rio Hondo.

Residues of DDD, DDE, DDT, and toxaphene continue to be present in fish at concentrations greater than the national baseline concentrations. These concentrations, although less than those measured in the 1970's, are of concern. Softshell turtles also contain large concentrations of organochlorine insecticides. The widespread occurrence of DDT and its metabolites, DDD and DDE, and toxaphene in fish and turtles indicates that the compounds are being incorporated into the food chain.

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SUPPLEMENTAL INFORMATION

Table 22.--Selected water-quality properties and constituents

[°C, degrees Celsius; mm, millimeters; µS/cm, microsiemens per centimeter at 25° Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Sampling site (fig. 3)	Date	Time	Temperature (°C)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	Oxygen dissolved (percent saturation)	pH (standard units)
1	06/24/86	0915	28.5	1,120	7.4	96	7.9
2	06/24/86	1715	29.5		8.3	115	8.0
3	06/24/86	1430	32.0	2,090	3.8	50	7.2
4	06/25/86	0830	29.0	5,400	3.5	46	7.5
4	06/25/86	0835	--	--	--	--	--
4	08/05/86	1345	--	--	--	--	--
5	06/25/86	1420	28.5	14,300	7.6	102	8.6
6	06/26/86	1515	30.0	1,740	3.7	49	7.7
7	06/26/86	0815	31.0		6.9	92	7.8
8	06/27/86	1345	28.0	14,400	5.3	70	7.9
8	08/05/86	1345	--	--	--	--	--
9	06/27/86	0715	29.0	8,240	5.5	72	7.9
9	08/05/86	1345	--	--	--	--	--
10	07/27/86	1110	29.0	11,500	7.4	99	8.1
11	07/27/86	1405	30.0	13,000	8.8	120	9.0
12	07/27/86	1315	29.0	9,440	8.7	115	8.7
13	06/25/86	1540	30.5	29,200	11.6	169	8.7
13	07/09/86	2030	--	--	--	--	--
14	06/28/86	0830	28.5	68,200	1.8	30	8.3
15	06/28/86	1000	29.0	19,200	6.3	86	7.9

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Arsenic, dis-solved (µg/L as As)	Barium, dis-solved (µg/L as Ba)	Boron, dis-solved (µg/L as B)	Cadmium, dis-solved (µg/L as Cd)	Chro-mium, dis-solved (µg/L as Cr)	Copper, dis-solved (µg/L as Cu)	Lead, dis-solved (µg/L as Pb)	Mercury, dis-solved (µg/L as Hg)	Molyb-denim, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)
1									6	
2	42	200200	780220	<1<1	<10<10	<1010	<5<5	<<0.1.1	9	18 5
3	7	200	840	<1	<10	10	<5	< .1	70	4
4	8	--	2,100	1	<10	20	<5	< .1	18	3
4	8	--	2,100	1	<10	20	<5	< .1	19	2
			--							
5	--	--		--	--	--	--	--	--	--
6	69	300200	2,100 440	<1<1	<10 <10	<10 30	<5<5	<< .1.1	106	162
					<10	<10	<5	< .1	7	2
8	11	110--	2,200	1	20	40	<5	< .1	11	1
8	--	--	--	--	--	--	--	--	--	--
9	10	--	1,600	<1	<10	20	<5	< .1	13	2
9	--			--	--	--	--	--	--	--
10	14	200	2,600	<1	<10	20	<5	.1	33	4
11	6	--	2,800	2	<10	20	<5	< .1	27	4
12	4	--	5,300	<1	30	50	<5	< .1	19	1
13	7	300	3,400	1	20	40	<5	.5	11	4
13	--	--	--	--	--	--	--	--	--	--
14	13	--	11,000	<1	50	110	<5	< .1	1	1
15	9	--	3,200	<1	20	60	<5	.1	20	5

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Selenium, dissolved (µg/L as Se)	Silver, dis-solved (µg/L as Ag)	Vana-dium, dis-solved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Uranium natural, dissolved (µg/L as U)	Gross alpha radioactivity, dissolved (µg/L as U natural)	Radium-226, dissolved planchet count (pCi/L)
2	1	<1	4	<10	4.4	9.2	0.1
3	1 1	<1 <1	9	<10 20	5.1	<10	< .2
			16		4.6	<16	.1
4	2	<1	44	<10	12	<49	< .2
4	2	<1	44	<10	13	39	.4
4	--	--	--	--	--	--	--
5	<1	<1	120	10	5.8	<48	.4
6	<1	<1	4	<10	2.7	<8.5	.3
7	<1	<1	6	<10	3.0	<9.8	.1
8	<1	<1	--	<10	4.0	<57	.3
8	--	--	--	--	--	--	--
9	<1	<1	--	20	9.0	<55	.2
9	--	--	--	--	--	--	--
10	<1	<1	82	10	4.1	<70	.3
11	<1	<1	--	<10	.4	<59	.1
12	<1	<1	350	30	.5	<150	.2
13	<1	<1	270	30	6.5	<200	.2
13	--	--	--	--	--	--	--
14	<1	<1	--	40	.8	<280	.2
15	1	<1	--	20	41	<75	.5

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Propazine, total (µg/L)	Perthane, total (µg/L)	Simetryne, total (µg/L)	Simazine, total (µg/L	Prometone, total (µg/L)	Prometryne, total (µg/L)
1	<0.1	<1.0	<0.1	<0.1	<0.1	<0.1
2	< .1	<1.0	< .1	< .1	< .1	< .1
3	< .1	<1.0	< .1	.6	1.7	< .1
4	< .1	<1.0	< .1	< .1	< .1	< .1
4	< .1	<1.0	< .1	.1	< .1	< .1
4	< .1	<1.0	< .1	.3	< .1	< .1
5	< .1	<1.0	< .1	< .1	< .1	< .1
6	< .1	<1.0	< .1	< .1	< .1	< .1
7	< .1	<1.0	< .1	< .1	< .1	< .1
8	< .1	<1.0	< .1	< .1	< .1	< .1
8	< .1	<1.0	< .1	< .1	< .1	< .1
9	< .1	<1.0	< .1	< .1	< .1	< .1
9	< .1	<1.0	< .1	< .1	< .1	< .1
10	< .1	<1.0	< .1	< .1	< .1	< .1
11	< .1	--	< .1	< .1	< .1	< .1
12	< .1	<1.0	< .1	< .1	< .1	< .1
13	--	--	--	--	--	--
13	--	<1.0	--	--	--	--
14	< .1	<1.0	< .1	< .1	< .1	< .1
15	< .1	<1.0	< .1	< .1	< .1	< .1

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Naph-tha-lenes poly-chlor-inated, total (µg/L)	Aldrin, total (µg/L)	Lindane, total (µg/L)	Chlor-dane, total (µg/L)	DDD, total (µg/L)	DDE, total (µg/L)	DDT, total (µg/L)	Di-eldrin, total (µg/L)	Endo-sulfan, total (µg/L)	Endrin, total (µg/L)	Ethion, total (µg/L)
1	<0.1	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	< .01	<.01	< .01
3	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	< .01	<.01	< .01
4	< .1	<.01	<.01	< .1	--	<.01	<.01	<.01	< .01	<.01	< .01
4	< .1	<.01	<.01	< .1	--	<.01	<.01	<.01	< .01	<.01	< .01
4	< .1	<.01	<.01	< .1	--	<.01	<.01	<.01	<.01	<.01	<.01
5	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
6	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
7	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
8	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
8	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
9	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
9	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
10	< .1	<.01	<.01	< .1	<.01	<.01	<.01	<.01	<.01	<.01	<.01
11	--	--	--	--	--	--	--	--	--	--	--
12	< .1	<.01	<.01	< .1	< .01	<.01	<.01	< .01	<.01	<.01	<.01
13	--	--	--	--	--	--	--	--	--	--	--
13	< .1	< .01	< .01	[illegible]	< .01	< .01	< .01	< .01	< .01	< .01	<.01
14	< .1	< .01	< .01	[illegible]	< .01	< .01	< .01	< .01	< .01	< .01	<.01
15	< .1	< .01	< .01	[illegible]	< .01	< .01	< .01	< .01	< .01	< .01	<.01

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Toxaphene, total (µg/L)	Heptachlor, total (µg/L)	Heptachlor epoxide, total (µg/L)	Methoxychlor, total (µg/L)	PCB, total (µg/L)	Malathion, total (µg/L)	Picloram, total (µg/L)	2,4-D, total (µg/L)	2,4,5-T, total (µg/L)	Sevin, total (µg/L)	Mirex, total (µg/L)
1	<1	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<2.0	<0.01
2	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
3	<1	< .01	< .01	< .01	< .1	.71	< .01	< .01	< .01	<2.0	< .01
4	<1	< .01	< .01	< .01	< .1	.01	< .01	< .01	< .01	<2.0	< .01
4	<1	< .01	< .01	< .01	< .1	.01	< .01	< .01	< .01	<2.0	< .01
4	<1	< .01	< .01	< .01	< .1	.05	.01	.13	< .01	<2.0	< .01
5	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
6	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
7	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
8	<1	< .01	< .01	< .01	< .1	< .01	.01	< .01	< .01	<2.0	< .01
8	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
9	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
9	<1	< .01	< .01	< .01	< .1	< .01	< .01	.11	< .01	<2.0	< .01
10	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
11	--	--	--	--	--	--	< .01	< .01	< .01	<2.0	--
12	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	--	< .01
13		--	--	--	--	--	< .01	< .01	< .01	<2.0	--
13	<1	< .01	< .01	< .01	< .1	< .01	--	--	--	--	< .01
14	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01
15	<1	< .01	< .01	< .01	< .1	< .01	< .01	< .01	< .01	<2.0	< .01

Table 22.--Selected water-quality properties and constituents--Continued

Sampling site (fig. 3)	Silvex, total (µg/L)	Tri-thion, total (µg/L)	Methyl tri-thion, total (µg/L)	Cyan-azine, total (µg/L)	Dicamba, total (µg/L)	2,4-DP, total (µg/L)	Ame-tryne, total (µg/L)	Para-thion, total (µg/L)
1	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.1	<0.01
2	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< .01
3	< .01	< .01	< .01	< .1	< .03	< .01	< .1	< .01
4	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< .01
4	< .01	< .01	< .01	< .1	.05	< .01	< .1	< .01
4	< .01	< .01	< .01	< .1	.05	< .01	< .1	< .01
5	< .01	< .01	< .01	< .1	.04	< .01	< .1	< .01
6	< .01	< .01	< .01	< .1	.01	< .01	< .1	< .01
7	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< .01
8	< .01	< .01	< .01	< .1	.01	< .01	< .1	< .01
8	< .01	< .01	< .01	< .1	.03	< .01	< .1	< .01
9	< .01	< .01	< .01	< .1	.03	< .01	< .1	< .01
9	< .01	< .01	< .01	< .1	.04	< .01	< .1	< .01
10	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< .01
11	< .01	--		--	< .01	< .01	< .1	< .01
12	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< .01
13	< .01	--	--	< .1	< .04	< .01	< .1	< .01
13	--	< .01	< .01	--	--	--	--	--
14	--	< .01	< .01	< .1	.03	< .01	< .1	< .01
15	< .01	< .01	< .01	< .1	< .01	< .01	< .1	< 01

Table 23.--Selected minor elements and pesticides in bed sediments

[μg/g, micrograms per gram]

Sampling site (fig. 6)	Arsenic, total (μg/g as As)	Barium, total (μg/g as Ba)	Beryllium, total (μg/g as Be)	Bismuth, total (μg/g as Bi)	Cadmium, total (μg/g as Cd)	Cesium, total (μg/g as Ce)	Chromium, total (μg/g as Cr)	Cobalt, total (μg/g as Co)	Copper, total (μg/g as Cu)
1	5.4	580	<1	<1	<2	95	57	11	10
2	5.1	490	1	<1	<2	53	47	11	16
3	5.6	480	1	<1	<2	56	46	12	28
4	5	510	2	<1	<2	61	53	13	32
5	4	380	2	<1	<2	57	52	11	21
7	6.2	510	1	<1	<2	52	37	9	22
8	6.59.4	440480	11	<1<1	<2<2	4757	4832	139	1854
			2	<1	<2	59	49	12	26
10	7.8	470	1	<1	<2	50	39	10	19
11	4.9	460	1	<1	<2	59	41	10	30
12	5.2	510	1	<1	<2	59	40	9	17
13	6.7	430	1	<1	<2	51	42	10	13
14	8.9	350	1	<1	<2	48	39	10	22
15	3.7	350	2	<1	<2	62	53	9	61

Table 23.--Selected minor elements and pesticides in bed sediments--Continued

Sampling site (fig. 6)	Europium, total (µg/g as Eu)	Gallium, total (µg/g as Ga)	Gold, total (µg/g as Au)	Holmium, total (µg/g as Ho)	Lanthanum, total (µg/g as La)	Lead, total (µg/g as Pb)	Lithium, total (µg/g as Li)	Manganese, total (µg/g as Mn)	Molybdenum, total (µg/g as Mo)
1	<2	11	<8.0	<4	51	15	24	520	<2
2	<2	13	<8.0	<4	28	16	36	560	<2
3	<2	16	<8.0	<4	29	33	41	890	<2
4	<2	17	<8.0	<4	32	28	46	1,300	<2
5	<2	16	<8.0	<4	31	16	40	570	<2
7	<2	15	<8.0	<4	28	17	32	630	<2
8	<2 <2	11	<8.0 <8.0	<4 <4	25 30	45	40	730	<2
						15	30	560	<2
9	<2	17	<8.0	<4	31			1,600	<2
10	<2	14	<8.0	<4	27	22	45		
11	<2	12	<8.0	<4	32	15 16	37 36	620 690	<2 <2
12	<2	13	<8.0	<4	31	13	37	730	2
13	<2	14	<8.0	<4	28	15	38	700	<2
14	<2	13	<8.0	<4	25	16	40	550	<2
15	<2	18	<8.0	<4	33	41	51	280	<2

Table 23.--Selected minor elements and pesticides in bed sediments--Continued

Sampling site (fig. 6)	Neodymiun, total (µg/g as Nd)	Nickel, total (µg/g as Ni)	Scandium, total (µg/g as Sc)	Selenium, total (µg/g as Se)	Silver, total (µg/g as Ag)	Strontium, total (µg/g as Sr)	Tantalum, total (µg/g as Ta)	Thorium, total (µg/g as Th)	Tin, total (µg/g as Sn)
1	40	13	6	0.3	<2	330	<40	17	<10
2	22	18	7	.4	<2	350	<40	10	<10
3	23	22	8	.5	<2	440	<40	9	<10
4	25	23	9	.5	<2	450	<40	11	<10
5	25	22	9	.4	<2	320	<40	11	<10
7	22	17	6	.6	<2	460	<40	10	<10
8	19 24	15 21	8 5	.4	<2 <2	420 470	<40 <40	10 7	<10 <10
9	25	24	9	.5	<2	450	<40	12	<10
10	21	18	6	.3	<2	440	<40	7	<10
11	24	19	6	.3	<2	450	<40	10	<10
12	25	16	6	.4	<2	480	<40	9	<10
13	19	17	6	.4	<2	450	<40	8	<10
14	26	19	6	.5	<2	670	<40	8	<10
15		25	10	.3	<2	360	<40	12	<10

Table 23.--Selected minor elements and pesticides in bed sediments--Continued

Sampling site (fig. 6)	Titanium, total (µg/g as Ti)	Uranium, total (µg/g as U)	Vanadium, total (µg/g as V)	Ytterbium, total (µg/g as Yb)	Yttrium, total (µg/g as Y)	Zinc, total (µg/g as Zn)
1	0.59	<100	81	3	21	60
2	.28	<100	69	2	19	75
3	.28	<100	68	2	20	95
4	.31	<100	77	3	22	100
5	.33	<100	67	2	20	94
6	.29	<100	55	2	19	78
7	.31	<100	76	2	21	130
8	.25	<100	49	2	17	61
9	.29	<100	77	2	21	100
10	.26	<100	59	2	18	64
11	.29	<100	64	2	19	67
12	.32	<100	60	2	19	59
13	.30	<100	63	2	18	65
14	.24	<100	65	2	18	82
15	.32	<100	82	3	22	99

Table 23.--Selected minor elements and pesticides in bed sediments--Continued

Sampling site (fig. 3)	PCN, total in bottom material (μg/kg)	Aldrin, total in bottom material (μg/kg)	Lindane, total in bottom material (μg/kg)	Chlordane, total in bottom material (μg/kg)	DDD, total in bottom material (μg/kg)	DDE, total in bottom material (μg/kg)	DDT, total in bottom material (μg/kg)	Dieldrin, total in bottom material (μg/kg)	Endosulfan, total in bottom material (μg/kg)
1	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--
4	--	--	--			--	--	--	--
4	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--		--	--
5	--	--	--	--				--	--
6	<0.1	<0.01	<0.01	<1.0	2.3	34	<0.01	0.2	<0.01
7	< .1	< .01	< .01	4.0	9.7	9.3	7.3	.1	< .01
8	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--	--
9	--	--	--	--	--	--	--	--	--
9	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--	--	--
11	--	--	--	--	--	--		--	--
12	--	--	--	--	--	--	--	--	--
13	--	--	--	--		--	--	--	--
13	--	--					--	--	--
14	< .1	< .01	< .01	<1.0	< .1	.5	< .01	< .01	< .01
15	< .1	< .01	< .01	<1.0	< .1	.2	< .01	< .01	< .01

Table 23.--Selected minor elements and pesticides in bed sediments--Continued

Sampling site (fig. 3)	Endrin, total in bottom material (µg/kg)	Ethion, total in bottom material (µg/kg)	Toxaphene, total in bottom material (µg/kg)	Heptachlor, total in bottom material (µg/kg)	Heptachlor epoxide, total in bottom material (µg/kg)	Methoxychlor, total in bottom material (µg/kg)	PCB, total in bottom material (µg/kg)	Mirex, total in bottom material (µg/kg)	Trithion, total in bottom material (µg/kg)	Methyl trithion, total in bottom material (µg/kg)	Perthane, total in bottom material (µg/kg)
1	--	--	--				--	--	--	--	--
2	--	--	--	--	--	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	--	--	--
4	--	--		--	--	--	--	--	--	--	--
4	--		--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--
6	<0.01	<0.01	<10	<0.1	<0.1	<0.1	<1.0	<0.01	<0.01	<0.01	<1.0
7	< .01	< .01	<10	< .1	< .1	< .1	<1.0	< .01	< .01	< .01	<1.0
8	--	--	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--	--	--	--
9	--	--	--	--	--	< .1	--	--	--	--	--
9	--	--	--	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--	--	--	--	--
11	--	--	--	--	--	--	--	--	--	--	--
12	--		--			--	--	--	--	--	
13	--	--	--	--	--	--		--	--	--	--
13	--	--	--	--	--	--	--	--	--	--	--
14	< .01	< .01	<10	< .1	< .1	< .1	<1.0	< .01	< .1	< .1	<1.0
15	< .01	< .01	<10	< .1	< .1	< .1	<1.0	< .01	< .1	< .1	<1.0

Table 24.--Minor elements in biota

[µg/g, micrograms per gram for indicated weight; ND, not determined]

Sample indification	Matrix	Aluminum µg/g (wet)	Aluminum µg/g (dry)	Arsenic µg/g (wet)	Arsenic µg/g (dry)	Barium µg/g (wet)	Barium µg/g (dry)
LRGV-1-86LMB	Fish	3.0	12	0.054	0.21	0.44	1.7
LRGV-1-86ST	Turtle	15	56	.042	<.16	2.2	8.1
LRGV-1-86SBH	Fish	3.3	12	.086	.31	.84	3.0
LRGV-1-86C	Fish	19	85	.042	.19	2.1	9.6
LRGV-1-86GS	Fish	530	2,300	.27	1.2	7.9	34
LRGV-2A-86CC	Fish	2.3	10	<.045	<.20	.22	.96
LRGV-2B-86CC	Fish	20	94	.088	.40	.38	1.8
LRGV-2-86ST	Turtle	27	96	.045	<.16	1.3	4.8
LRGV-2-86C	Fish	9.2	41	.039	.17	.89	3.9
LRGV-2-86GS	Fish	14	65	.10	.47	1.9	8.9
LRGV-3-86GS	Fish	190	600	.092	.29	1.6	4.9
LRGV-3-86ST	Turtle	16	54	<.047	<.16	.57	1.9
LRGV-5-86-SC	Fish	13	70	1.0	5.2	.098	.51
LRGV-5-86CB	Crab	2.9	11	.28	1.1	.098	.38
LRGV-5-86GS	Fish	18	69	.15	.56	.69	2.6
LRGV-6-86ST	Turtle	51	180	x.048	<.17	1.8	6.3
LRGV-6-86T	Tilapia species	10	42	<.042	<.17	.55	2.3
LRGV-6-86SM	Fish	ND	ND	.070	.25	ND	ND
LRGV-7-86ST	Turtle	18	64	<.049	<.17	4.4	15
LRGV-8-86ST	Turtle	22	96	<.046	<.20	2.3	9.8
LRGV-8-86SM	Fish	27	100	<.042	<.16	2.2	8.1
LRGV-8-86GK	Fish	9.0	36	.068	.27	.89	3.5
LRGV-9-86BCB	Crab	76	290	1.2	4.5	9.7	38
LRGV-9-86ST	Turtle	31	120	<.044	<.17	1.0	4.0
LRGV-9-86BC	Fish	6.8	35	.11	.56	.14	.71
LRGV-9-86AG	Fish	5.5	16	.11	.33	.61	1.8
LRGV-10-86FWD	Fish	2.3	9.0	.29	1.2	.33	1.3
LRGV-10-86C	Fish	3.0	14	.13	.59	.19	.86
LRGV-10A-86BC	Fish	3.1	14	.12	.54	.14	.62
LRGV-10B-86BC	Fish	3.0	12	.12	.48	.13	.56
LRGV-10-86BNS	Stilt	8.7	24	.16	.45	1.2	3.5
LRGV-10A-86CH	Chara	450	3,100	1.8	12	4.5	31
LRGV-10B-86CH	Chara	430	3,700	2.1	18	5.4	47
LRGV-11A-86BCB	Crab	70	280	1.1	4.4	5.7	22
LRGV-11B-86BCB	Crab	42	170	1.1	4.2	3.3	13
LRGV-13-86-SC	Fish	2.3	9.7	.30	1.3	.64	2.7
LRGV-13-86CB	Crab	48	170	1.1	4.0	.097	.34
LRGV-60-86FM	Fish	35	100	.19	.54	.098	.29

Table 24.--Minor elements in biota--Continued

Sample identification	Matrix	Beryllium µg/g (wet)	Beryllium µg/g (dry)	Boron µg/g (wet)	Boron µg/g (dry)	Cadmium µg/g (wet)	Cadmium µg/g (dry)
LRGV-1-86LMB	Fish	<0.095	co.37	<4.8	<19	<0.095	<0.37
LRGV-1-86ST	Turtle	<.098	<.37	<4.9	<18	<.098	<.37
LRGV-1-86SBH	Fish	<.10	<.36	<5.0	<18	x.10	<.36
LRGV-1-86C	Fish	<.096	<.44	5.0	23	<.096	<.44
LRGV-1-86GS	Fish	<.099	<.42	<5.0	<21	.099	x.42
LRGV-2A-86CC	Fish	x.099	<.43	6.3	28	x.099	<.43
LRGV-2B-86CC	Fish	<.095	<.44	<4.8	<22	<.095	<.44
LRGV-2-86ST	Turtle	<.097	<.35	<4.9	<18	<.097	<.35
LRGV-2-86C	Fish	<.099	<.43	5.7	25	<.099	x.43
LRGV-2-86GS	Fish	<.097	<.45	<4.8	<22	<.097	x.45
LRGV-3-86GS	Fish	<.097	<.30	<4.9	<15	<.097	<.30
LRGV-3-86ST	Turtle	<.099	<.33	<4.9	<16	<.099	<.33
LRGV-5-86-SC	Fish	<.098	<.51	5.3	28	<.098	<.51
LRGV-5-86CB	Crab	<.098	<.38	5.9	23	<.098	<.38
LRGV-5-86GS	Fish	<.098	<.37	<4.9	<19	<.098	x.37
LRGV-6-86ST	Turtle	<.099	<.35	<5.0	<17	<.099	<.35
LRGV-6-86T	Tilapia species	<.099	<.41	5.0	20	x.099	<.41
LRGV-6-86SM	Fish	NO	ND	ND	ND	ND	ND
LRGV-7-86ST	Turtle	x.095	<.34	<4.7	<17	<.095	x.34
LRGV-8-86ST	Turtle	<.095	<.41	<4.7	<20	<.095	<.41
LRGV-8-86SM	Fish	x.10	<.37	<5.0	<19	<.10	<.37
LRGV-8-86GK	Fish	<.099	<.39	<5.0	<20	<.099	<.39
LRGV-9-86BCB	Crab	<.095	x.37	9.7	38	<.095	<.37
LRGV-9-86ST	Turtle	<.098	<.38	(4.9	<19	<.098	<.38
LRGV-9-86BC	Fish	x.097	<.51	<4.9	<25	<.097	<.51
LRGV-9-86AG	Fish	<.096	<.28	<4.8	<14	<.096	<.28
LRGV-10-86FWD	Fish	<.097	<.38	<4.8	<19	<.097	<.38
LRGV-10-86C	Fish	<.097	<.43	<4.8	<22	<.097	<.43
LRGV-10A-86BC	Fish	<.097	<.44	<4.9	<22	<.097	<.44
LRGV-10B-86BC	Fish	<.096	<.40	<4.8	<20	<.096	<.40
LRGV-10-86BNS	Stilt	<.099	<.28	7.7	22	<.099	<.28
LRGV-10A-86CH	Chara	<.098	<.67	7.9	53	<.098	<.67
LRGV-10B-86CH	Chara	<.097	<.83	11	92	<.097	<.83
LRGV-11A-86BCB	Crab	<.097	<.39	9.2	36	<.097	<.39
LRGV-11B-86BCB	Crab	<.097	<.38	5.5	21	<.097	<.38
LRGV-13-86-SC	Fish	<.097	<.41	<4.9	<21	<.097	<.41
LRGV-13-86CB	Crab	x.097	<.34	5.2	18	x.097	<.34
LRGV-60-86FM	Fish	<.098	<.29	<4.9	<14	<.098	<.29

Table 24.--Minor elements in biota--Continued

Sample indification	Matrix	Chromium µg/g (wet)	Chromium µg/g (dry)	Copper µg/g (wet)	Copper µg/g (dry)	Iron µg/g (wet)	Iron µg/g (dry)
LRGV-I-86LMB	Fish	co.095	co.37	0.23	0.89	6.7	26.0
LRGV-1-86ST	Turtle	<.098	<.37	.24	.88	18	68
LRGV-1-86SBH	Fish	<.10	<.36	2.4	8.6	7.0	25
LRGV-I-86C	Fish	1.1	4.8	.65	3.0	35	160
LRGV-1-86GS	Fish	.63	2.7	.18	.76	400	1,700
LRGV-2A-86CC	Fish	<.099	<.43	.12	.52	9.3	41
LRGV-2B-86CC	Fish	.11	.53	.25	1.1	13	58
LRGV-2-86ST	Turtle	<.097	<.35	.43	1.5	31	110
LRGV-2-86C	Fish	.099	<.43	.81	3.6	19	84
LRGV-2-86GS	Fish	.12	.54	.29	1.3	21	98
LRGV-3-86GS	Fish	.35	1.1	.14	.43	150	460
LRGV-3-86ST	Turtle	<.099	<.33	.20	.66	<.99	<3.3
LRGV-5-86-SC	Fish	<.098	<.51	<.098	<.51	<.98	<5.1
LRGV-5-86C8	Crab	<.098	<.38	x.098	<.38	<.98	(3.8
LRGV-5-86GS	Fish	.45	1.7	.35	1.3	26	96
LRGV-6-86ST	Turtle	.32	1.1	.16	.56	58	200
LRGV-6-86T	Tilapia species	3.4	14	.42	1.7	26	110
LRGV-6-86SM	Fish	ND	ND	ND	ND	ND	ND
LRGV-7-86ST	Turtle	.19	.67	.21	.74	23	.81
LRGV-8-86ST	Turtle	<.095	<.41	.21	.90	21	90
LRGV-8-86SM	Fish	[illegible]	3.5	3.0	11	34	130
LRGV-8-86GK	Fish	.93	3.7	.81	3.2	15	60
LRGV-9-86BCB	Crab	<.095	<.37	12	46	40	160
LRGV-9-86ST	Turtle	<.098	<.38	.43	1.7	49	190
LRGV-9-86BC	Fish	<.097	<.51	.19	1.0	12	60
LRGV-9-86AG	Fish	.23	.66	.34	.99	13	37
LRGV-10-86FWD	Fish	<.097	<.38	.42	1.7	3.9	15
LRGV-10-86C	Fish	<.097	<.43	.71	3.2	13	58
LRGV-10A-86BC	Fish	<.097	<.44	.47	2.1	6.8	31
LRGV-10B-86BC	Fish	.15	.63	.23	.95	10	42
LRGV-10-86BNS	Stilt	.14	.39	1.4	3.9	36	100
LRGV-10A-86CH	Chara	.73	4.9	.57	3.9	190	1,300
LRGV-10B-86CH	Chara	.89	7.7	.45	3.8	230	2,000
LRGV-11A-86BCB	Crab	.12	.47	16	64	60	240
LRGV-11B-86BCB	Crab	<.097	<.38	9.0	35	25	99
LRGV-13-86-SC	Fish	<.097	<.41	.66	2.8	11	48
LRGV-13-86CB	Crab	<.097	<.34	.45	1.6	39	140
LRGV-60-86FM	Fish	<.098	<.29	<.098	<.29	35	100

Table 24.--Minor elements in biota--Continued

Sample indification	Matrix	Lead µg/g (wet)	Lead µg/g (dry)	Magnesium µg/g (wet)	Magnesium µg/g (dry)	Manganese µg/g (wet)	Manganese µg/g (dry)
LRGV-1-86LMB	Fish	<0.19	<0.74	310	1,200	<0.95	<3.7
LRGV-1-86ST	Turtle	<.20	<.74	290	1,100	<.98	<3.7
LRGV-l-86SBH	Fish	<.20	<.72	300	1,100	<1.0	<3.6
LRGV-I-86C	Fish	<.19	<.88	290	1,300	1.4	6.4
LRGV-l-86GS	Fish	<.20	<.84	360	1,500	13	53
LRGV-2A-86CC	Fish	<.20	<.87	240	1,000	<.99	<4.3
LRGV-2B-86CC	Ffsh	<.19	X.88	210	960	<.95	<4.4
LRGV-2-86ST	Turtle	<.19	<.70	210	770	1.2	4.4
LRGV-2-86C	Fish	<.20	x.87	240	1,000	<.99	<4.3
LRGV-2-86GS	Fish	<.19	<.89	230	1,100	1.8	8.3
LRGV-3-86GS	Fish	<.19	<.61	330	1,000	7.5	23
LRGV-3-86ST	Turtle	<.20	<.66	170	580	4.2	14
LRGV-5-86-SC	Fish	<.20	a.0	<.98	<5.1	<.98	<5.1
LRGV-5-86CB	Crab	<.20	<.77	<.98	<3.8	<.98	<3.8
LRGV-5-86GS	Fish	<.20	<.74	290	1,100	1.6	6.1
LRGV-6-86ST	Turtle	<.20	<.70	170	620	2.4	8.6
LRGV-6-86T	Tilapia species	<.20	<.81	260	1,100	6.8	28
LRGV-6-86SM	Fish	ND	ND	ND	ND	ND	ND
LRGV-7-86ST	Turtle	<.19	x.67	280	1,000	1.1	4.0
LRGV-8-86ST	Turtle	<.19	<.82	320	1,400	3.1	13
LRGV-8-86SM	Fish	<.20	<.74	360	1,300	13	50
LRGV-8-86GK	Fish	<.20	<.78	360	1,400	9.4	37
LRGV-9-86BCB	Crab	<.19	<.74	360	1,400	32	120
LRGV-9-86ST	Turtle	<.20	<.76	310	1,200	3.2	12
LRGV-9-86BC	Fish	<.19	a.0	210	1,100	1.8	9.4
LRGV-9-86AG	Fish	<.19	<.55	360	1,000	1.8	5.1
LRGV-10-86FWD	Fish	<.19	<.77	230	920	1.8	7.2
LRGV-10-86C	Fish	<.19	<.86	250	1,100	1.1	4.8
LRGV-10A-86BC	Fish	<.19	X.88	250	1,200	2.6	12
LRGV-10B-86BC	Fish	<.19	<.79	210	870	3.3	14
LRGV-IO-86BNS	Stilt	.93	2.6	220	610	1.1	3.1
LRGV-10A-86CH	Chara	<.20	<1.3	370	2,500	35	240
LRGV-10B-86CH	Chara	.35	3.0	370	3,200	54	460
LRGV-11A-86BCB	Crab	<.19	<.78	510	2,000	54	210
LRGV-11B-86BCB	Crab	<.19	<.76	510	2,000	25	96
LRGV-13-86-SC	Fish	<.19	x.83	330	1,400	2.8	12
LRGV-13-86CB	Crab	<.19	<.68	290	1,000	15	53
LRGV-60-86FM	Fish	<.20	<.57	<.98	<2.9	<.98	<2.9

Table 24.--Minor elements in biota--Continued

Sample identification	Matrix	Mercury µg/g (wet)	Mercury µg/g (dry)	Molybdenum µg/g (wet)	Molybdenum µg/g (dry)	Nickel µg/g (wet)	Nickel µg/g (dry)
LRGV-1-86LMB	Fish	co.040	<0.15	<0.095	<0.37	--	--
LRGV-1-86ST	Turtle	<.042	<.16	<.098	<.37	--	--
LRGV-I-86SBH	Fish	<.048	<.17	<.10	<.36	--	--
LRGV-1-86C	Fish	<.046	<.21	<.096	<.44	--	--
LRGV-1-86GS	Fish	<.041	<.17	<.099	<.42	--	--
LRGV-2A-86CC	Fish	x.038	<.17	<.099	<.43	--	--
LRGV-2B-86CC	Fish	.042	.19	<.095	<.44	--	--
LRGV-2-86ST	Turtle	.059	.21	<.097	<.35	--	--
LRGV-2-86C	Fish	<.041	<.18	<.099	<.43	--	--
LRGV-2-86GS	Fish	<.040	<.18	<.097	<.45	--	--
LRGV-3-86GS	Fish	<.049	<.15	<.097	<.30	--	--
LRGV-3-86ST	Turtle	.077	.26	<.099	<.33	--	--
LRGV-5-86-SC	Fish	.16	.82	<.098	<.51	--	--
LRGV-5-86CB	Crab	.078	.31	<.098	<.38	--	--
LRGV-5-86GS	Fish	.038	.15	<.098	<.37	--	--
LRGV-6-86ST	Turtle	.058	.20	<.099	<.35	--	--
LRGV-6-86T	Tilapfa species	.058	.24	<.099	<.41	--	--
LRGV-6-86SM	Fish	<.049	<.18	ND	ND	ND	NO
LRGV-7-86ST	Turtle	.081	.29	<.095	<.34	--	--
LRGV-8-86ST	Turtle	.060	.26	<.095	<.41	--	--
LRGV-8-86SM	Fish	<.045	<.17	<.10	<.37	--	--
LRGV-8-86GK	Fish	.044	.17	<.099	<.39	--	--
LRGV-9-86BCB	Crab	.068	.26	<.095	<.37	--	--
LRGV-9-86ST	Turtle	.075	.29	<.098	<.38	0.63	2.4
LRGV-9-86BC	Fish	.11	.59	<.097	<.51	<.097	<.51
LRGV-9-86AG	Fish	.20	.58	<.096	<.28	.15	.44
LRGV-10-86FWD	Fish	.058	.23	<.097	<.38	<.097	<.38
LRGV-10-86C	Fish	.052	.23	<.097	<.43	<.097	<.43
LRGV-10A-86BC	Fish	.063	.29	<.097	<.44	<.097	<.44
LRGV-10B-86BC	Fish	.079	.32	<.096	<.40	<.096	<.40
LRGV-10-86BNS	Stilt	.27	.77	<.099	<.28	<.099	<.28
LRGV-10A-86CH	Chara	<.039	<.27	<.098	<.67	.24	1.6
LRGV-10B-86CH	Chara	<.038	<.33	<.097	<.83	.29	2.5
LRGV-11A-86BCB	Crab	.050	.20	.37	1.5	<.097	<.39
LRGV-11B-86BCB	Crab	.049	.19	.25	.99	<.097	<.38
LRGV-13-86-SC	Fish	.20	.87	.39	1.7	<.097	<.41
LRGV-13-86CB	Crab	.061	.22	<.097	<.34	<.097	<.34
LRGV-60-86FM	Fish	<.046	X.14	x.098	<.29	<.098	<.29

Table 24.--Minor elements in biota--Continued

Sample identification	Matrix	Selenium µg/g (wet)	Selenium µg/g (dry)	Strontium µg/g (wet)	Strontium µg/g (dry)	Tin µg/g (wet)	Tin µg/g (dry)
LRGV-1-86LMB	Fish	0.87	3.4	34	130	<0.95	<3.7
LRGV-1-86ST	Turtle	.38	1.4	55	210	2.2	8.1
LRGV-1-86SBH	Fish	.95	3.4	38	140	<1.0	<3.6
LRGV-1-86C	Fish	.52	2.4	48	220	4.8	22
LRGV-l-86GS	Fish	.41	1.7	48	200	61	260
LRGV-2A-86CC	Fish	.33	1.4	20	86	<.99	<4.3
LRGV-2B-86CC	Fish	.33	1.5	15	67	1.0	4.8
LRGV-2-86ST	Turtle	.30	1.1	29	110	4.7	17
LRGV-2-86C	Fish	.50	2.2	24	100	2.0	8.7
LRGV-2-86GS	Fish	.56	2.6	23	110	2.5	12
LRGV-3-86GS	Fish	.19	.59	23	73	19	60
LRGV-3-86ST	Turtle	.17	.57	17	57	1.5	4.9
LRGV-5-86-SC	Fish	.57	3.0	24	120	5.1	27
LRGV-5-86CB	Crab	.20	.80	25	100	6.3	25
LRGV-5-86GS	Fish	.37	1.4	26	96	3.5	13
LRGV-6-86ST	Turtle	.19	.68	24	84	8.5	30
LRGV-6-86T	Tilapia species	.27	1.1	36	150	4.0	16
LRGV-6-86SM	Fish	.35	1.3	ND	ND	ND	ND
LRGV-7-86ST	Turtle	.25	.90	68	240	2.8	10
LRGV-8-86ST	Turtle	.15	.64	130	570	3.0	13
LRGV-8-86SM	Fish	.30	1.1	120	440	4.8	18
LRGV-8-86GK	Fish	.30	1.2	95	370	2.0	7.8
LRGV-9-86BCB	Crab	.21	.83	290	1,100	5.5	21
LRGV-9-86ST	Turtle	<.044	<.17	110	420	6.9	27
LRGV-9-86BC	Fish	.38	2.0	25	130	1.5	8.0
LRGV-9-86AG	Fish	.28	.81	55	160	1.6	4.5
LRGV-10-86FWD	Fish	.57	2.3	50	200	<.97	<3.8
LRGV-10-86C	Fish	.63	2.8	66	290	1.7	7.5
LRGV-10A-86BC	Fish	.38	1.7	43	190	<.97	<4.4
LRGV-10B-86BC	Fish	.22	.91	35	140	1.5	6.3
LRGV-10-86BNS	Stilt	.47	1.3	19	53	5.3	15
LRGV-10A-86CH	Chara	.057	.39	110	770	29	200
LRGV-10B-86CH	Chara	<.046	<.40	130	1,100	35	300
LRGV-11A-86BCB	Crab	.22	.86	310	1,200	3.5	14
LRGV-11B-86BCB	Crab	.26	1.0	160	630	3.9	15
LRGV-13-86-SC	Fish	.37	1.6	50	210	1.2	5.0
LRGV-13-86CB	Crab	.32	1.1	230	820	6.2	22
LRGV-60-86FM	Fish	.67	2.0	96	280	6.8	20

Table 24.--Minor elements in biota--Continued

Sample Identification	Matrix	Vanadium µg/g (wet)	Vanadium µg/g (dry)	Zinc µg/g (wet)	Zinc µg/g (dry)
LRGV-1-86LMB	Fish	<0.095	<0.37	8.7	34
LRGV-1-86ST	Turtle	<.098	<.37	16	61
LRGV-1-86SBH	Fish	<.10	<.36	11	39
LRGV-l-86C	Fish	.13	.61	51	230
LRGV-l-86GS	Fish	.91	3.9	6.4	27
LRGV-2A-86CC	Fish	<.099	<.43	9.6	42
LRGV-28-86CC	Fish	.11	.53	10	46
LRGV-2-86ST	Turtle	<.097	<.35	14	49
LRGV-2-86C	Fish	<.099	<.43	49	220
LRGV-2-86GS	Fish	.15	.71	6.5	30
LRGV-3-86GS	Fish	.41	1.3	6.1	19
LRGV-3-86ST	Turtle	<.099	<.33	13	44
LRGV-5-86-SC	Fish	<.098	<.51	<.98	<5.1
LRGV-5-86CB	Crab	<.098	<.38	<.98	<3.8
LRGV-5-86GS	Fish	.14	.52	10	39
LRGV-6-86ST	Turtle	<.099	<.35	9.8	35
LRGV-6-86T	Tilapia species	.18	.73	16	64
LRGV-6-86SM	Fish	ND	ND	ND	ND
LRGV-7-86ST	Turtle	<.095	<.34	15	53
LRGV-8-86ST	Turtle	<.095	<.41	16	68
LRGV-8-86SM	Fish	.28	1.0	15	57
LRGV-8-86GK	Fish	<.099	<.39	25	100
LRGV-9-86BCB	Crab	<.095	<.37	12	49
LRGV-9-86ST	Turtle	<.098	<.38	16	60
LRGV-9-86BC	Fish	<.097	<.51	11	57
LRGV-9-86AG	Fish	<.096	<.28	7.2	21
LRGV-10-86FWD	Fish	<.097	<.38	7.6	30
LRGV-10-86C	Fish	.14	.60	25	110
LRGV-10A-86BC	Fish	<.097	<.44	9.6	44
LRGV-10B-86BC	Fish	<.096	<.40	8.0	33
LRGV-10-86BNS	Stilt	<.099	c.28	17	49
LRGV-10A-86CH	Chara	.88	6.0	<.98	<6.7
LRGV-10B-86CH	Chara	.64	5.5	<.97	<8.3
LRGV-11A-86BCB	Crab	<.097	x.39	6.3	25
LRGV-11B-86BCB	Crab	.12	.46	8.7	34
LRGV-13-86-SC	Fish	.16	.66	85	360
LRGV-13-86CB	Crab	<.097	<.34	21	73
LRGV-60-86FM	Fish	<.098	<.29	<.98	<2.9

Table 25.--Organochlorine insecticides and PCB-1254 in biota

[µg/g, micrograms per gram1

Sample identification	Matrix	cis-Chlordane µg/g (wet)	cis-Chlordane µg/g (dry)	trans-Chlordane µg/g (wet)	trans-Chlordane µg/g (dry)	p,p'-DDE µg/g (wet)	p,p'-DDE µg/g (dry)
LRGV-1-86LMB	Fish	<0.0095	co.037	<0.0095	<0.037	4.0	16
LRGV-I-86ST	Turtle	<.0096	<.036	<. 0096	<.036	.35	1.3
LRGV-1-86SBH	Fish	<.0098	<.035	<.0098	<.035	.35	1.2
LRGV-1-86C	Fish	<.0099	<.045	<.0099	<.045	.17	.78
LRGV-1-86GS	Fish	<.0097	<.041	<.0097	<.041	.036	.15
LRGV-2A-86CC	Fish	<.0099	<.043	<.0099	<.043	3.0	13
LRGV-2B-86CC	Fish	<.0098	<.045	<.0098	<.045	1.5	6.9
LRGV-2-86ST	Turtle	<.0097	x.035	<.0097	<.035	2.6	9.3
LRGV-2-86C	Fish	<.0099	<.044	< .0099	<.044	.35	1.5
LRGV-2-86GS	Fish	<.010	<.046	x.010	<.046	.77	3.6
LRGV-3-86GS	Fish	<.0099	<.031	<.0099	<.031	9.9	31
LRGV-3-86ST	Turtle	x.010	<.033	<.010	<.033	9.1	30
LRGV-5-86-SC	Fish	<. 0098	<.051	<.0098	<.051	.29	1.5
LRGV-5-86CB	Crab	x.0094	<.037	<.0094	x.037	1.1	4.5
LRGV-5-86GS	Fish	<.0097	<.037	<.0097	<.037	.56	2.1
LRGV-6-86ST	Turtle	<.0096	x.034	<.0096	<.034	4.2	15
LRGV-6-86T	Tilapia species	<.0099	x.041	<.0099	<.041	.16	.65
LRGV-6-86SM	Fish	<.025	<.091	<.025	<.091	.19	.70
LRGV-7-86ST	Turtle	<.0097	<.034	<.0097	<.034	1.4	4.9
LRGV-8-86ST	Turtle	<.010	<.043	<.010	<.043	.38	1.6
LRGV-8-86SM	Fish	<.0098	x.036	<.0098	<.036	.27	1.0
LRGV-8-86GK	Fish	<.0096	<.038	<.0096	<.038	.38	1.5
LRGV-9-86BCB	Crab	x.0095	<.037	<.0095	<.037	.61	2.4
LRGV-9-86ST	Turtle	<.0097	<.037	<.0097	<.037	1.6	6.2
LRGV-9-86BC	Fish	<.0097	<.950	<.0097	<.950	2.0	10
LRGV-9-86AG	Fish	x.0096	<.028	<.0096	<.028	5.8	17
LRGV-10-86FWD	Fish	<.0097	<.039	<.0097	<.039	.24	.95
LRGV-10-86C	Fish	<.0099	<.044	<.0099	<.044	.27	1.2
LRGV-10A-86BC	Fish	<.0093	<.042	<.0093	<.042	.38	1.7
LRGV-10B-86BC	Fish	<.0097	x.040	<.0097	<.040	1.6	6.6
LRGV-10-86BNS	Stilt	<.0095	<.027	<.0095	<.027	3.3	9.4
LRGV-10A-86CH	Chara	<.0092	<.062	<.0092	<.062	<.0092	<.062
LRGV-10B-86CH	Chara	<.0099	<.085	<.0099	<.085	x.0099	x.085
LRGV-11A-86BCB	Crab	<.0094	<.037	<.0094	<.037	.074	.30
LRGV-11B-86BCB	Crab	<.0098	<.039	<.0098	<.039	,084	.33
LRGV-13-86-SC	Fish	<.0098	<.042	<.0098	<.042	.30	1.3
LRGV-13-86CB	Crab	<.0096	<.034	<.0096	<.034	.080	.28
LRGV-60-86FM	Fish	<.0098	<.029	<.0098	<.029	2.0	5.9

Table 25.--Organochlorine insecticides and PCB-1254 in biota--Continued

Sample identification	Matrix	p,p'-DDD µg/g (wet)	p,p'-DDD µg/g (dry)	p,p'-DDT µg/g (wet)	p,p'-DDT µg/g (dry)	Dieldrin µg/g (wet)	Dieldrin µg/g (dry)
LRGV-1-86LMB	Fish	0.018	0.068	<0.0095	<0.37	(0.0095	<0.037
LRGV-l-86ST	Turtle	.013	.050	.021	.078	<.0096	<.036
LRGV-1-86SBH	Fish	.020	.071	.021	.075	<.0098	<.035
LRGV-l-86C	Fish	<.0099	<.045	<.0099	<.045	<.0099	<.045
LRGV-1-86GS	Fish	.016	.068	<.0097	<.041	<.0097	<.041
LRGV-2A-86CC	Fish	.079	.35	.055	.24	<.0099	<.043
LRGV-2B-86CC	Fish	.044	.20	.037	.17	<.0098	<.045
LRGV-2-86ST	Turtle	.033	.12	.033	.12	<.0097	x.035
LRGV-2-86C	Fish	.032	.14	.026	.11	<.0099	<.044
LRGV-2-86GS	Fish	.039	.18	.035	.16	<.010	<.046
LRGV-3-86GS	Fish	.18	.55	.054	.17	<.0099	.031
LRGV-3-86ST	Turtle	.064	.22	.045	.15	<.010	.033
LRGV-5-86-SC	Fish	.018	.094	<.0098	<.051	<.0098	<.051
LRGV-5-86CB	Crab	.030	.12	<.0094	x.037	<.0094	<.037
LRGV-5-86GS	Fish	.036	.14	.030	.11	x.0097	<.037
LRGV-6-86ST	Turtle	.026	.091	.046	.16	<.0096	<.034
LRGV-6-86T	Tilapia species	.020	.081	<.0099	<.041	<.0099	<.041
LRGV-6-86SM	Fish	.027	.098	<.025	<.091	x.025	x.091
LRGV-7-86ST	Turtle	.020	.070	<.0097	<.034	<.0097	<.034
LRGV-8-86ST	Turtle	.015	.064	<.010	<.043	<.010	<.043
LRGV-8-86SM	Fish	.022	.083	<.0098	<.036	<.0098	<.036
LRGV-8-86GK	Fish	,015	.059	<.0096	<.038	<. 0096	<.038
LRGV-9-868CB	Crab	.022	.087	<.0095	<.037	x.095	x.037
LRGV-9-86ST	Turtle	,017	.065	.037	.14	<.0097	<.037
LRGV-9-86BC	Fish	.061	.32	.038	.20	<.0097	<.050
LRGV-9-86AG	Fish	.16	.46	.066	.19	<.0096	.028
LRGV-10-86FWD	Fish	.015	.060	<.0097	<.039	x.0097	<.039
LRGV-10-86C	Fish	.017	.074	<.0099	<.044	<.0099	<.044
LRGV-10A-86BC	Fish	.021	.095	.024	.11	<.0093	<.042
LRGV-10B-86BC	Fish	.053	.22	.038	.16	<.0097	<.040
LRGV-10-86BNS	Stilt	.021	.059	.036	.10	<.0095	<.027
LRGV-10A-86CH	Chara	<.0092	<.062	<.0092	<.062	<.0092	<.062
LRGV-10B-86CH	Chara	<.0099	x.085	.077	.66	<.0099	<.085
LRGV-11A-86BCB	Crab	<.0094	<.037	<.0094	<.037	<.0094	x.037
LRGV-11B-86BCB	Crab	<.0098	<.039	<.0098	<.039	<.0098	<.039
LRGV-13-86-SC	Fish	.015	.063	<.0098	<.042	<.0098	<.042
LRGV-13-86CB	Crab	.012	.042	<.0096	<.034	<.0096	<.034
LRGV-60-86FM	Fish	.051	.15	.044	.13	<.0098	<.029

Table 25.--Organochlorine insecticides and PCB-1254 in biota--Continued

Sample identification	Matrix	Endrin µg/g (wet)	Endrin µg/g (dry)	Heptachlor epoxide µg/g (wet)	Heptachlor epoxide µg/g (dry)	cis-Nonachlor µg/g (wet)	cis-Nonachlor µg/g (dry)
LRGV-1-86LMB	Fish	<0.0095	co.037	<0.0095	co.037	(0.0095	co.037
LRGV-1-86ST	Turtle	<.0096	<.036	<.0096	<.036	<.0096	x.036
LRGV-1-86SBH	Fish	<.0098	<.035	<.0098	<.035	<.0098	<.035
LRGV-1-86C	Fish	<.0099	<.045	<.0099	x.045	<.0099	<.045
LRGV-1-86GS	Fish	<.0097	<.041	<.0097	<.041	<.0097	<.041
LRGV-2A-86CC	Fish	<.0099	<.043	<.0099	<.043	<.0099	<.043
LRGV-2B-86CC	Fish	<. 0098	<.045	<.0098	<.045	<.0098	<.045
LRGV-2-86ST	Turtle	<.0097	<.035	x.0097	<.035	<.0097	<.035
LRGV-2-86C	Fish	<.0099	<.044	<.0099	<.044	<. 0099	<.044
LRGV-2-86GS	Fish	<.010	<.046	x.010	<.046	<.010	<.046
LRGV-3-86GS	Fish	<.0099	<.031	<.0099	<.031	<.0099	<.031
LRGV-3-86ST	Turtle	<.010	<.033	<.010	<.033	<.010	<.033
LRGV-5-86-SC	Fish	<.0098	<.051	x.0098	<.051	<.0098	<.051
LRGV-5-86CB	Crab	<.0094	<.037	<.0094	<.037	x.0094	<.037
LRGV-5-86GS	Fish	<.0097	<.037	<.0097	<.037	<.0097	<.037
LRGV-6-86ST	Turtle	<.0096	<.034	<.0096	<.034	<.0096	<.034
LRGV-6-86T	Tilapia species	<.0099	<.041	<.0099	<.041	<.0099	<.041
LRGV-6-86SM	Fish	<.025	<.091	<.025	<.091	<.025	<.091
LRGV-7-86ST	Turtle	<.0097	<.034	<.0097	<.034	<.0097	x.034
LRGV-8-86ST	Turtle	<.010	<.043	<.010	<.043	x.010	<.043
LRGV-8-86SM	Fish	<.0098	<.036	<.0098	<.036	<.0098	<.036
LRGV-8-86GK	Fish	<.0096	<.038	<.0096	<.038	<.0096	<.038
LRGV-9-86BCB	Crab	<.0095	<.037	<.0095	<.037	x.0095	<.037
LRGV-9-86ST	Turtle	<.0097	<.037	<.0097	<.037	<.0097	<.037
LRGV-9-86BC	Fish	<.0097	<.050	<.0097	<.050	<.0097	x.050
LRGV-9-86AG	Fish	<.0096	<.028	<.0096	<.028	<.0096	<.028
LRGV-10-86FWD	Fish	<.0097	<.039	<.0097	<.039	<.0097	<.039
LRGV-10-86C	Fish	<.0099	<.044	<.0099	<.044	<.0099	<.044
LRGV-10A-86BC	Fish	<.0093	x.042	<.0093	<.042	<.0093	<.042
LRGV-10B-86BC	Fish	<.0097	<.040	<.0097	<.040	<.0097	<.040
LRGV-10-86BNS	Stilt	<.0095	<.027	<.0095	<.027	x.0095	<.027
LRGV-10A-86CH	Chara	<.0092	<.062	<.0092	<.062	<.0092	<.062
LRGV-10B-86CH	Chara	<.0099	x.085	<.0099	<.085	<.0099	<.085
LRGV-11A-86BCB	Crab	<.0094	x.037	<.0094	x.037	<. 0094	<.037
LRGV-11B-86BCB	Crab	<.0098	x.039	<.0098	<.039	<.0098	<.039
LRGV-13-86-SC	Fish	<.0098	<.042	<.0098	<.042	<.0098	<.042
LRGV-13-86CB	Crab	<.0096	<.034	<.0096	<.034	<.0096	<.034
LRGV-60-86FM	Fish	<.0098	<.029	<.0098	<.029	<.0098	<.029

Table 25.--Organochlorine insecticides and PCB-1254 in biota--Continued

Sample identification	Matrix	trans-Nonachlor µg/g (wet)	trans-Nonachlor µg/g (dry)	Oxychlordane µg/g (wet)	Oxychlordane µg/g (dry)	Estimated PCB-1254 µg/g (wet)	Estimated PCB-1254 µg/g (dry)
LRGV-1-86LMB	Fish	<0.0095	<0.037	<0.0095	<0.037	<0.095	<0.37
LRGV-1-86ST	Turtle	<.0096	<.036	<.0096	<.036	<.096	<.36
LRGV-1-86SBH	Fish	x.0098	x.035	<.0098	<.035	<.098	<.35
LRGV-1-86C	Fish	<.0099	<.045	<.0099	<.045	<.099	<.45
LRGV-1-86GS	Fish	<.0097	x.041	<.0097	<.041	<.097	<.41
LRGV-2A-86CC	Fish	<.0099	<.043	<.0099	<.043	<.099	<.43
LRGV-2B-86CC	Fish	<.0098	<.045	<.0098	<.045	<.098	<.45
LRGV-2-86ST	Turtle	<.0097	<.035	<.0097	<.035	<.097	<.35
LRGV-2-86C	Fish	<.0099	<.044	<.0099	<.044	<.099	<.44
LRGV-2-86GS	Fish	<.010	<.046	<.010	<.046	<.10	<.46
LRGV-3-86GS	Fish	<.0099	<.031	<.0099	<.031	.11	.35
LRGV-3-86ST	Turtle	<.010	<.033	<.010	<.033	.15	.52
LRGV-5-86-SC	Fish	<.0098	<.051	<.0098	<.051	<.098	<.51
LRGV-5-86CB	Crab	<.0094	<.037	x.0094	x.037	<.094	<.37
LRGV-5-86GS	Fish	<.0097	<.037	<.0097	<.037	<.097	<.37
LRGV-6-86ST	Turtle	<.0096	<.034	<.0096	<.034	<.096	<.34
LRGV-6-86T	Tilapia species	<.0099	<.041	<.0099	<.041	x.099	<.41
LRGV-6-86SM	Fish	<.025	<.091	<.025	<.091	<.25	<.91
LRGV-7-86ST	Turtle	<.0097	<.034	<.0097	<.034	<.097	<.34
LRGV-8-86ST	Turtle	<.010	<.043	<.010	<.043	<.10	<.43
LRGV-8-86SM	Fish	<.0098	<.036	x.0098	<.036	<.098	<.36
LRGV-8-86GK	Fish	<.0096	<.038	<.0096	<.038	<.096	<.38
LRGV-9-86BCB	Crab	<.0095	<.037	<.0095	<.037	x.095	<.37
LRGV-9-86ST	Turtle	<.0097	<.037	<.0097	<.037	<.097	<.37
LRGV-9-86BC	Fish	<.0097	<.950	<.0097	<.950	<.097	<.50
LRGV-9-86AG	Fish	<.0096	<.028	<.0096	<.028	.10	.29
LRGV-10-86FWD	Fish	<.0097	<.039	<.0097	<.039	<.097	<.39
LRGV-10-86C	Fish	<.0099	<.044	<.0099	<.044	x.099	x.44
LRGV-10A-86BC	Fish	<.0093	<.042	<.0093	<.042	<.093	<.42
LRGV-10B-86BC	Fish	<.0097	<.040	<.0097	<.040	<.097	<.40
LRGV-10-86BNS	Stilt	<.0095	<.027	<.0095	<.027	<.095	<.27
LRGV-10A-86CH	Chara	<.0092	<.062	<.0092	x.062	<.092	<.62
LRGV-10B-86CH	Chara	<.0099	<.085	<.0099	<.085	<.099	<.85
LRGV-11A-86BCB	Crab	<.0094	<.037	<.0094	<.037	<.094	<.37
LRGV-11B-86BCB	Crab	<.0098	<.039	<.0098	<.039	<.098	<.39
LRGV-13-86-SC	Fish	<.0098	x.042	<.0098	<.042	<.098	<.42
LRGV-13-86CB	Crab	x.0096	x.034	<.0096	<.034	<.096	<.34
LRGV-60-86FM	Fish	x.0098	<.029	<.0098	<.029	<.098	<.29

Table 25.--Organochlorine insecticides and PCB-1254 in biota--Continued

Sample identification	Matrix	Estimated toxaphene µg/g (Wet)	µg/g (dry)
LRGV-1-86LMB	Fish	<0.48	<1.8
LRGV-I-86ST	Turtle	<.48	<1.8
LRGV-1-86SBH	Fish	<.49	<1.8
LRGV-1-86C	Fish	<.50	<2.3
LRGV-1-86GS	Fish	<.48	x2.1
LRGV-2A-86CC	Fish	2.2	9.5
LRGV-2B-86CC	Fish	1.6	7.4
LRGV-2-86ST	Turtle	2.1	7.5
LRGV-2-86C	Fish	1.0	4.5
LRGV-2-86GS	Fish	1.1	5.0
LRGV-3-86GS	Fish	5.1	16
LRGV-3-86ST	Turtle	5.2	17
LRGV-5-86-SC	Fish	.98	5.1
LRGV-5-86CB	Crab	<.47	<1.8
LRGV-5-86GS	Fish	3.5	13
LRGV-6-86ST	Turtle	7.1	25
LRGV-6-86T	Tilapia species	x.50	<2.0
LRGV-6-86SM	Fish	<1.3	<4.5
LRGV-7-86ST	Turtle	1.6	5.8
LRGV-8-86ST	Turtle	<.50	<2.2
LRGV-8-86SM	Fish	<.49	<1.8
LRGV-8-86GK	Fish	x.48	<1.9
LRGV-9-868CB	Crab	<.47	<1.8
LRGV-9-86ST	Turtle	2.4	9.4
LRGV-9-86BC	Fish	2.2	11
LRGV-9-86AG	Fish	4.9	14
LRGV-10-86FWD	Fish	<.49	<1.9
LRGV-10-86C	Fish	<.49	<2.2
LRGV-10A-86BC	Fish	1.3	5.9
LRGV-10B-86BC	Fish	2.3	9.5
LRGV-10-86BNS	Stilt	<.47	<1.3
LRGV-10A-86CH	Chara	<.46	<3.1
LRGV-10B-86CH	Chara	<.49	<4.2
LRGV-11A-86BCB	Crab	x.47	<1.9
LRGV-11B-86BCB	Crab	<.49	<1.9
LRGV-13-86-SC	Fish	<.49	<2.1
LRGV-13-86CB	Crab	<.48	a.7
LRGV-60-86FM	Fish	3.1	9.0